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Co-operative Electric Lighting.

IT may not be out of place to again call attention to a subject which has more than once occupied a place in our columns—that is the lighting of small towns on the co-operative plan. There are many localities in and about New York, for example, where there are no electric lighting plants established, and in some of which the gas companies have successfully stifled any attempt at competition. It frequently happens that a dozen fine residences can be found within a short radius, and wherever such a nucleus exists it ought to be possible to put, in not a private plant, but a mutual installation to furnish light to all of them. Once started such a system could extend eventually to a sufficient number of dwellings so that the expense would not be heavy, probably not much more than gas. Beside furnishing light it would then be easy to put in fan motors for the summer months, run electric pumps, and perform all sorts of small services at remarkably low rates. The scheme has been tried in England in a number of cases with very excellent success, and it is well worth thinking about here, for electric light is so highly desirable that the absence of a considerable company is not sufficient reason for abandoning an attempt to procure it.

Primary Sources of Electricity.

A PRIMARY battery competition has been announced in Italy under the auspices of one of the electrical journals there, with the design of stimulating the inventors to the production of a practical source of electricity on a small scale. Something of the kind is badly needed, for a wide variety of electrical purposes, whether it is through the primary battery or some other form of apparatus to deponent unknown. A man cannot conveniently carry a dynamo and engine in his gripsack, nor is it convenient for him to take 15 or 20 storage cells under his arm and lug them home. We are constantly in receipt of inquiries for batteries, or something of the kind, and usually suggest a trial of some of the well known forms of Grove or bichromate batteries, of which there are many varieties, patented and otherwise. As a rule they give good service up to a certain point, but there is constantly a feeling that something a little better is wanted, and if our Italian friends can stimulate the improvement of some of the cells already existing, or rouse inventors to the point of devising something entirely new, they will have done an excellent service. The conditions that have to be fulfilled in a primary source of electricity are numerous and perplexing, and it is creditable to the ingenuity of mankind that they have been solved even so well as they have been. There is a constant call for a source of electricity on a comparatively small scale, in such form, however, that it will not require excessive care; cost in many cases is a secondary consideration. Such an apparatus should be of moderate bulk, should be clean, inodorous, should not require much attention, and should produce a current of constant potential. Not long ago there was a vigorous effort to exploit the thermo-battery for work on a small scale, but nothing came of it. The thermopile fulfills all the required conditions fairly well but is of inconveniently low voltage, somewhat costly to operate and of insufficient durability. A year of pretty steady use will usually paralyze a thermopile, and it is rather expensive to replace at such short periods. Another possibility in this line is the thermo-regenerative cell, a sort of storage battery in which heat plays the role of electricity in bringing the elements back to their initial state. Its use thus far has been experimental, and it apparently requires rather more care than most people would wish to give. A convenient source of electrical energy in small quantities is so useful and important a thing that every attempt to improve our present facilities deserves careful consideration and encouragement.

Tests on the Lauffen-Frankfort Plant.

FOR the last six months the great transmission of power plant between Lauffen-on-the-Neckar and Frankfort-on-the-Main has been a topic frequently treated in our columns. We have persistently predicted its success from the very start, and gave the first report of the favorable result. But our readers will look with special interest on the results of some of the later tests of the system as reported by Mr. Carl Hering on another page. The final results of the tests carried out at various times during the past summer are delayed with the customary deliberation of a German red tape office, and in view of this the preliminary report is peculiarly timely. In the beginning there were many fears not only that insulation under the very high voltages proposed would prove impracticable but that extraordinary sources of loss would be met, due principally to electrostatic effects of various sorts. These fears, however, have happily proved unfounded. No extraordinary losses of any kind were encountered, and Ohm's law, as usual, emerged triumphant from this new struggle with Nature. As regards difficulties in insulation, these proved to have been greatly overestimated: of all the insulators employed, numbering 10,000, only one broke down from the actual effects of the current, and this only when the original electromotive force of 15,000 volts had been cast aside and the pressure was boldly doubled. In the process of testing insulators before they are put up, of course a certain number were rejected, but it was feared that the small machine used for testing might not work in quite the same way as the immensely powerful transformers employed in the actual installation. This fear was illfounded. Two kinds of insulators were used upon the line, one of them of great size, and the other comparatively small, both employed oil insulation, the largest one with three oil films, the smaller one with but one. Quite as good results were obtained from the smaller size, perhaps due to the fact that it was possible to employ a better grade of porcelain than on the insulators of larger bulk. Only thrice did any accident occur to cause stoppage of the plant, one due to the insulator before mentioned, one to breakage of the wire, and the third to one of the insulators cracking from mechanical strain. This result is most satisfactory as regards insulation and the line of work in general. A test of the efficiency showed that a little over 72 per cent. of the energy delivered by the generator at Lauffen was given to the lamps in Frankfort, a success that can hardly be overestimated when one considers the great distance and the entire novelty of the apparatus. There is every reason to count this great experiment as one of the most striking performances of the past decade, that has shown so many magnificent electrical developments.

Another Attack on the Trolley.

WE regret to say that Mayor Boody, of Brooklyn, has seen fit to put his official veto on the ordinance passed only two weeks ago permitting the change in motive power from horses to electricity on the surface roads of Brooklyn. It was not expected that the subject would come up for his official consideration at all, but through the intervention of holidays the limit of ten days given for official consideration after the ordinance was passed was construed to extend through the 2d of January, and on that day the Mayor vented his feeling toward the trolley system by vetoing it. It would be an interesting matter, albeit not perhaps one altogether satisfactory to the moral sense, to know what manner of influences are steadily working against the erection of any trolley system, not only in Brooklyn but in other places. It may usually be traced approximately to the jealousy of business rivals in and about New York—the elevated roads. But what ought the public to think of that dog-in-the-manger policy that impels resistance on the part of the corporations to anything that means rapid transit, while they refuse to facilitate it themselves? The attitude of the daily press is particularly unfortunate in this matter, for the fairness that usually characterizes its attitude toward innovations seems to be abandoned when the trolley system comes in question and its columns give place only to abuse and misrepresentation. The system has been abundantly tried in Boston and was demonstrated its great usefulness. Its effect in enhancing the value of real estate along the lines is very marked all over the country, and it is but an unreasoning prejudice that has produced the opposition now so unfortunately manifested. Elsewhere serious objections have been raised only to its introduction in certain residence streets, like Fifth avenue in this city, where the most strenuous efforts are made by the wealthy property holders to discourage anything that savors of democracy. The situation in Brooklyn is decidedly unpleasant, though we trust the Board of Aldermen will have sufficient persistence and courage to pass the ordinance over the Mayor's veto and thus prevent a single obstinate man from blocking the wheels of progress in a city of nearly a million inhabitants. It is to be hoped that the real animus of this veto cannot be traced to purely commercial reasons. In New York striking comment may be made on the relations of the elevated roads to surface rapid transit. The most vicious opposition has been made to introducing the trolley system, while the more dangerous cable obtained the necessary franchises without very serious difficulty. Several conclusions might be drawn from this, the most obvious one being that the elevated roads do not consider the cable a dangerous competitor, while they dread the effect of introducing electric rapid transit in opposition to their own miserably conducted lines.

Electric Block Signals.

THE recent accident on the New York Central Railroad has forced to public attention in almost unparalleled violence the woful lack on that system of the most ordinary precautions against accident that can be found on foreign railroads. To attempt the operation of a great road with an unusually large number of very fast trains without the most complete and perfect system of guards against collision that the mind of man can devise is simply to trust the lives of the passengers to blind chance, and it is but a pitiful excuse, put forward by the officials, that they were waiting until they could find the ideal block signal system in order to apply it, for it is the duty of a railroad to protect the passengers who intrust themselves to it by the best means in their power at all times quite irrespective of what the future may bring in the way of additional safeguards. The dreadful rear end collision of Christmas Eve forced home to the management of the New York Central road their own reckless disregard of public safety with fearful emphasis, for that accident did not repeat the story that so often has been told of the sudden rush of a train from the track, pulverizing the day coaches and smoker between the wrecked engine and the heavy sleepers, with the escape of the passengers in the latter. Such is the usual history of an accident, but this time it was a sleeper that was crushed, protecting by its solidity the train beyond, but sacrificing nearly every passenger in the car, among them friends of the officials of the railroad, to whose negligence the dreadful result was due. One would have supposed that the fearful rear end collision at Spuyten Duyvil 10 years ago would have spurred the railroad managers into activity, but it has taken a decade of minor collisions and this last horror to awaken them to a sense of their responsibility, and there are plenty of systems that would have precluded the possibility of accidents of this sort, or at least reduced their chance of occurring to a very high degree of improbability. The Pennsylvania system has been specially active in protecting its lines by the best methods at its command. In this work of rendering safe the operation of railroads electricity, as usual, comes into play with admirable effect. Without the aid of electricity it would be almost impracticable to operate a modern railway, simply from the lack of intercommunication between its successive stations. It took some years for the railway telegraph to force its way into general use, but now it is indispensable, and the electric block signal is likely to assume a similar position; electric we say advisedly, for practically all the block systems in use rely upon electricity in one way or another. The applications of electricity to such safety appliances, various in kind and degree, vary widely, from mere electric signaling from block to block operated by hand to the automatic operation of the signals all along the line by electric power alone. Elsewhere in our columns is sketched out a general account of some of these electric block signal systems, taking up in succession those which use the current as a means of communication only, those which use it both for communication and for actuating semi-automatic track apparatus, and, finally, a type of those which employ electric power throughout and render the system as nearly as possible independent of the "personal error" that must eventually stand behind every device of human invention. The account is necessarily incomplete, for to describe all the block signal systems that have been applied or proposed would require volumes. It, however, will give the reader a general idea of some of the typical forms which are finding their way into general railway practice at the present time, and will serve to impress more forcibly than by mere assertion the direful neglect that is the unfortunate occasion of the public attention that has been attracted to the subject.

Latest Foreign Electrical News.

(By Cable from Our Own Correspondent.)

LONDON, Jan. 4, 1892.—The Queen has just created Sir William Thomson a peer of the realm. This royal recognition of his long continued and important services to the cause of science is richly deserved, and will be the source of great satisfaction in scientific circles throughout the world. Her Majesty has always shown the keenest appreciation of the development of the arts and sciences, and the greatest liberality toward those who have promoted them. Sir William Thomson was knighted years ago in honor of his most valuable services in connection with transatlantic telegraphy, and this new recognition of his merits and labors in the branches of physical science is cause for congratulation.

Lord Salisbury now promises a parliamentary inquiry on the question of electric communication with lighthouses and lightships; the importance of this has been shown over and over again, but the government has been tardy in appreciating it.

The Electrical Exhibition at the Crystal Palace, for which extensive preparations have been going on throughout the last few months, will be opened on Jan. 9.

The fares on the City & South London Railway have been raised during the business hours.

Progress of Mr. Tesla's High Frequency Work.

During the past six months Mr. Nikola Tesla has been steadily at work developing the beautiful principles that he enunciated in his striking lecture before the American Institute of Electrical Engineers. In his skillful hands the experiments have extended far beyond their merely theoretical importance in the direction of important practical applications. Part of the fruits of his industry has already appeared in his method patents on incandescent lighting, another patent on condensers and divers applications that are now in the Patent Office. Many of the practical difficulties that at first appeared have been overcome and we may ere long see the results in commercial work. Meanwhile the transmission of power has not been forgotten, and some interesting improvements in that line may soon be expected, especially as the use of the methods embodied in Mr. Tesla's early patents has recently made such a sensation abroad. About the middle of January Mr. Tesla expects to sail for Europe, to deliver, at the urgent request of his English friends, a lecture on his high frequency researches and to look after his foreign interests generally. The trip will be a flying one of only a couple of months, as the pressure of work at home forbids a long absence. On his return some of the latest commercial developments of his work may be expected to appear as promptly as circumstances will permit. The revolutionary character of his methods will make any extensive application of them of unique interest.

The Financial Side of Electric Lighting.

The members of the National Electric Light Association are to be favored at the Buffalo meeting next month with an elaborate treatment of this topic by Mr. Erastus Wiman. In order to secure the necessary information to enable him to treat the subject in the most exhaustive manner Mr. Wiman has sent out to central station managers the following request for their co-operation in the work. The letter says:

"Having had the honor of being specially designated by Mr. C. R. Huntley, president of the National Electric Light Association, to address the next convention at Buffalo on the special subject of the financial side of electric lighting, I am desirous of all the help I can get to make a careful and strong presentation of the merits of this class of property. There is believed to be in the public mind, and especially in financial circles, a growing prejudice adverse to securities based on electrical properties. It would seem important at this juncture that as clear a view as possible should be had of the real facts of the case. Hence, it would be very desirable if I could be placed in possession of instances of successful companies, with particulars of the amounts of their stock, the length of time before dividends were paid, and the amounts regularly realized, cost of maintenance, and such other facts as can readily be got together. Some special instances of very successful concerns are particularly wished for, and the history of companies which have not at first been successful but which have since been rescued from insolvency by good management, also any facts relating to combinations between gas and electric light companies, and how best it can be promoted.

"If you happen to have anything of that kind and can send it for me to Mr. George F. Porter, 136 Liberty street, New York, I shall be much indebted."

ELECTRICAL WORLD PORTRAITS.—NO. XXX.

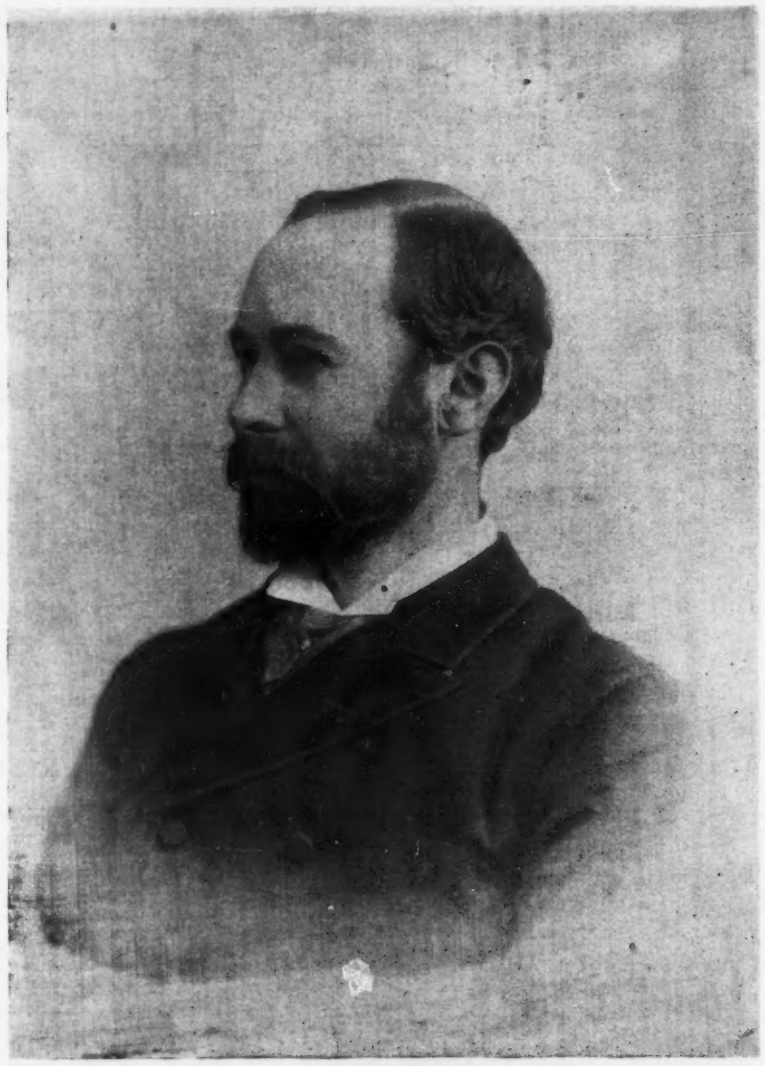
PROF. SILVANUS P. THOMPSON.

We present this week a portrait of perhaps the best known electrician and writer on electrical subjects now living, one whose name is thoroughly familiar both to scientists and practical engineers all the world over.

Silvanus P. Thompson is a native of York, England, where he was born in 1851. His early education was at the Friends' school in his native place, but he afterward studied at the London University, taking the degree of A. B. in 1869. Even then his attention was turned to science rather than to literature, and he went on with his studies with a view of beginning the academic career that he has followed. Chemistry and physics were his special and favorite studies, and after leaving London University he studied at the Royal School of Mines, and later for short periods at Heidelberg and other foreign institutions. In 1875 he was graduated as Bachelor of Science in the University of London, and three years later took the degree of D. S. C., experimental physics being his special subject. In that year he went to Bristol University College as professor of experimental physics, and there began that course of popular lectures on practical subjects that have gained so much fame for him since.

He delivered during 1878 a course of lectures on technical applications of electricity, and a little later organized the thoroughly equipped physical laboratory at that college.

From 1878 Prof. Thompson has been untiring as a teacher



PROF. SILVANUS P. THOMPSON.

and investigator, and his contributions to current scientific literature have been very numerous, bearing ample witness to the activity of his scientific life. Optics and electricity have been the subjects of most of his researches.

Prof. Thompson's widest reputation among practical men, however, has been gained by his studies of applied electricity, especially with reference to electrical mechanism. He worked for a time on electrical storage, and very soon after the electric light began to come to public notice made a careful investigation of the theory of dynamo electric machines, which was embodied in his Cantor Lectures before the Society of Arts, which were delivered in the autumn of 1883. They were the first attempt to put the subject in clear popular form and received the widest recognition. About the same time appeared the first edition of his remarkable little book, "Elementary Lessons in Electricity and Magnetism," which as a text book has achieved a success almost beyond belief, and remains to-day, with the various revisions it has since undergone, by all odds the best elementary book on the subject. That volume has the record of having reached a circulation of more than 40,000 copies in English alone, besides widely read translations into French, German and Polish.

In 1884 came the important volume on dynamo-electric machines, which has run through three editions without showing any signs of being superseded by any later work. There is no better all-around practical electrical treatise in the language, and the non-appearance of the long-promised revised fourth edition is the subject of lamentation among electrical students. The book in addition has been translated into French and German. Several other important volumes have come from Prof. Thompson's pen, of which we may specially note his biography of Philip Reis, the inventor of the telephone, and the splendid Cantor lectures of 1890, on the electro-magnet, which were published at the time in THE ELECTRICAL WORLD; followed later by another course on electro-magnetic mechanism, less extended but scarcely less interesting.

In 1884, when Prof. W. E. Ayrton was elected to the chair of physics at the City and Guilds of London Central Institution, Prof. Thompson took his place at the City and Guilds of London Technical College of Finsbury, of which he is now the principal.

When it is remembered that all his scientific work has been done while he was already burdened with his academic duties, his prodigious activity will be the better appreciated. About a year ago his constant services in the cause of science were recognized by his election as a Fellow of the Royal Society, and to judge from present appearances there will be no cessation of his untiring labors in the cause of scientific technical education and scientific research.

Lauffen-Frankfort Transmission of Power—Results of Tests.

BY CARL HERING.

Those who are interested in the Lauffen-Frankfort transmission of power experiment, described in these columns during the past year, will be pleased to hear that information just received indicates that the scientific tests which have been made by the learned German professors will show results which were even more satisfactory than was anticipated. In a personal letter just received by the writer, from the best authority, the results are thus tersely given: "Results successful in the highest degree; no 'extraordinary' losses; all passed off according to Ohm's law." It will be remembered that great fears were entertained that a transmission of this kind, with such high voltages, would show extraordinary losses which are not deducible from Ohm's law, and do not exist in the ordinary systems of transmission, and which arise from such causes as the condenser actions of the insulators and the line, phase lagging, etc. It will be remembered by those who read the above mentioned articles, that one of the chief objects in making this experiment was to find out whether such extraordinary losses existed at all, and if so, to obtain data from which it would be possible to calculate to what extent they would enter into the calculation of plants designed according to this system. It is therefore highly satisfactory to hear that these fears were not realized. It is all the more satisfactory because these experiments are the largest transmission of power experiments ever attempted, exceeding all others by a very large amount. Those who undertook it, namely, the Allgemeine Elektricitäts Gesellschaft, and the Oerlikon Works, with their respective engineers, Dobrowolsky and Brown, deserve great credit.

In view of the fact that the publication of the official results will no doubt be greatly delayed, the following translation of a preliminary report just received by the writer from the Oerlikon company may be of interest. This report shows a commercial efficiency of over 72 per cent. between the energy as delivered by the generator at Lauffen, and that received at the lamps in Frankfort—a result which certainly is satisfactory to the highest degree. It gives the cost of such a plant as $282 per effective horse-power. It will be remembered that the distance was about 110 miles, and that the line wires consisted of three copper wires of four millimetres diameter (about a No. 6 B. & S. wire), and 10,000 insulators, containing oil films. For further details, the reader is referred to the descriptions above referred to. We give below the translation of the article just as it was received:

In view of the fact that so many reports and descriptions have been published in all the large technical and other journals, about the Lauffen-Frankfort transmission of power experiments, as carried out by the joint co-operation of the Oerlikon company, of Switzerland, and the Allgemeine Elektricitäts Gesellschaft, which reports have awakened such a live interest in the matter, and in view of the fact that in recent references suspicions were advanced as to why the results of the measurements made by the Commission of Experts of the Exposition were not published, it is quite natural that the engineering profession is awaiting with impatience the official report of this commission. As much time will yet be required before the mass of figures obtained from these expert tests will be published, it no doubt will be appreciated by many, if we give here some measurements which were made while the plant was in full operation, and which, therefore, will serve very well for a basis of an opinion on the result.

As was mentioned in the descriptions which were published, the voltage of the current used averaged about 16,000 volts (measured between any two wires of the secondary circuit). In the beginning it was the intention to increase the voltage to 30,000 volts; this was carried

out at the conclusion of the tests made by the Commission of Experts by connecting the high tension circuits of the transformers in series. It was shown in the very beginning after the transmission was started, that the fears expressed, that among the large number of insulators there would be some which could not stand the high tension, were unnecessarily pessimistic. Among the 10,000 insulators, there was only one which broke down, and this was when the 30,000 volts were used. This is all the more interesting because these insulators had been tested with but a small machine, and with only 30,000 volts, and it would have been expected that among such a large number, there would be a few which were doubtful. In the two other cases which entailed stoppages, one was due to the breakage of a wire and the other to a breakage of an insulator; in the latter case the nature of the breakage showed that the insulator was not broken by the current, but was probably strained internally by a too rapid cooling during the manufacture, and that, therefore, the cracking may be safely attributed to mechanical strains. As a matter of fact, a large number of these insulators, broke from this cause during the erection of the plant. It should be especially noted that these failures were only among the large insulators, that is, those with three oil films; among the smaller ones with single oil films not a single one broke or failed on the application of the current, notwithstanding that these small ones were used only as a last resort, because a sufficient number of the others could not be obtained in time. Besides this, there were many more small insulators on the line than the large ones. All this goes to show that the fractures which did occur may be traced to defects in the workmanship, due to the great haste in which these insulators had to be made. It shows, furthermore, that a satisfactory insulation of such a plant can be obtained with relatively simple means and small cost.

In order to render this more evident, a calculation is given here of the cost of a plant under the assumption that 300 h. p. is generated in Lauffen (the machines and transformers were calculated for this output) and that all the energy received in Frankfort was converted into light. The cost of plant per effective horse-power (measured at the poles of the lamp) will in that case be 1,200 marks (about $282), of which 1,000 marks (about $236) is for the line. It cannot, therefore, be stated that such a plant will in all cases be remunerative, but it must not be forgotten that in this particular plant there were conditions which would not be likely to occur in practice, namely, relatively small power on the one hand and an exceptionally great distance on the other hand, both of which factors naturally increase the cost per horse-power.

Notwithstanding this, it may be considered demonstrated that it is not only possible to carry out such an installation from an engineering standpoint, but also that it is a success from a commercial point of view, when large powers are transmitted over smaller distances, as, for instance, for 50 or 100 kilometres (30 to 60 miles). In practice the need of such transmissions will rarely exceed this, as there are many cases in which large powers are, as a rule, required in even smaller districts than in such a one of 100 kilometres diameter.

The question which is at present exciting much interest is, how much of the power which was generated in Lauffen was available in Frankfort? On this depends the conclusion whether and under what circumstances such a plant would be practicable from a commercial standpoint. The question whether such a transmission is possible from an engineering standpoint is to-day no longer disputable, in view of the fact that the waterfall and the triumphal arch of lamps in Frankfort were seen by so many witnesses.

While the plant was running, simultaneous measurements were made regularly at both places which, although they were made with the commercial ampère and voltmeters on the switchboards, give sufficiently exact results for practical purposes. From these measurements the following figures were obtained: On the switchboard in Lauffen the currents in the three circuits were 500, 490, 500 ampères, in the main circuit of the dynamo the voltage measured between each of the three wires and the neutral point was 54 volts. Neglecting for the present the lagging of the phase between the current and the voltage, these figures give an average output of $(500 + 490 + 500) \times 54 = 80{,}500$ watts. At the same time there were burning in Frankfort 10,060 lamps of 16 candles or their equivalent, which consumed an amount of energy equal to $10{,}060 \times 55 =$ 58,000 watts. The efficiency calculated from this is therefore 72 per cent. measured at the poles of the dynamo in Lauffen and the secondary terminals of the transformers in Frankfort. This efficiency is, however, in reality greater than 72 per cent., because the energy which we have assumed to have been generated in Lauffen is not in reality merely the product of the mean current with the corresponding mean voltage, but should be measured by multiplying this product by a factor which is dependent on the phase difference, and which is always smaller than unity. The output in Lauffen was therefore less than 80,500 watts, and the total efficiency therefore greater than 72 per cent. As shown by other means this correction would amount to about 5 per cent. Although these results leave an uncertainty of a few per cent. (which, however, can only be in favor of a better figure), it may be stated here, in order to settle the doubt which still exists so widely, that it has been proved that the Lauffen-Frankfort transmission gave not only a relatively good efficiency, but that its actual efficiency was very favorable.

GEORGE F. GREEN.

This is furthermore substantiated by the following observations. As the transmission was carried on during very different kinds of weathers, it was natural to suppose that the direct loss by leakage to the earth during the rainy weather might become very appreciable. This, however, was not the case, the instruments indicating absolutely the same result as during dry weather. Even though such a direct leakage of current may have actually existed, yet the above will show beyond dispute that these losses were inappreciably small, and that they can safely be neglected in practice, especially as the leakage did not lead to any interruptions.

Regarding the condenser action, which was at the time advanced as one of the very doubtful questions, it was noticed that by disconnecting the transformers in Frankfort, although the ampère meters in the primary circuit in Lauffen indicated a very great current, namely, 200 ampères each, this current does not represent a correspondingly high loss, because of the phase difference, which was very great under these circumstance. As a matter of fact, this loss can be shown to have been very small, by the use of a device in connection with the turbine, in place of a wattmeter, which was not available. This device consisted in regulating the valves in the inner ring of the turbine inlets. It was found by this means that the turbine was giving off only a very small amount of power, even though the dynamo was giving off 250 ampères in each one of the three circuits. If, now, the line was disconnected, there was of course no current indicated, but the turbine valves had to remain in almost exactly the same position in order to keep the number of revolutions constant. The power developed by the turbine was from 4 to 5 h. p., and was determined subsequently by a brake test made at the same speed and with the same supply; this therefore represents the total loss required to charge the line. From this it can be concluded that the energy consumed in charging the line alone does not represent any appreciable loss of energy, but that this loss consists chiefly of the energy which the charging current consumes in overcoming the resistance of the wire; but even this loss is still very small in comparison with the total energy and relatively to the length of the line.

The results given here briefly, and obtained from experiments covering a long series of tests, show that in such a transmission abnormal phenomena of no kind enter which would introduce an element of uncertainty in projecting similar installations; on the contrary, they show that the principal losses which really occur are like those in low tension currents, deducible merely from Ohm's law.

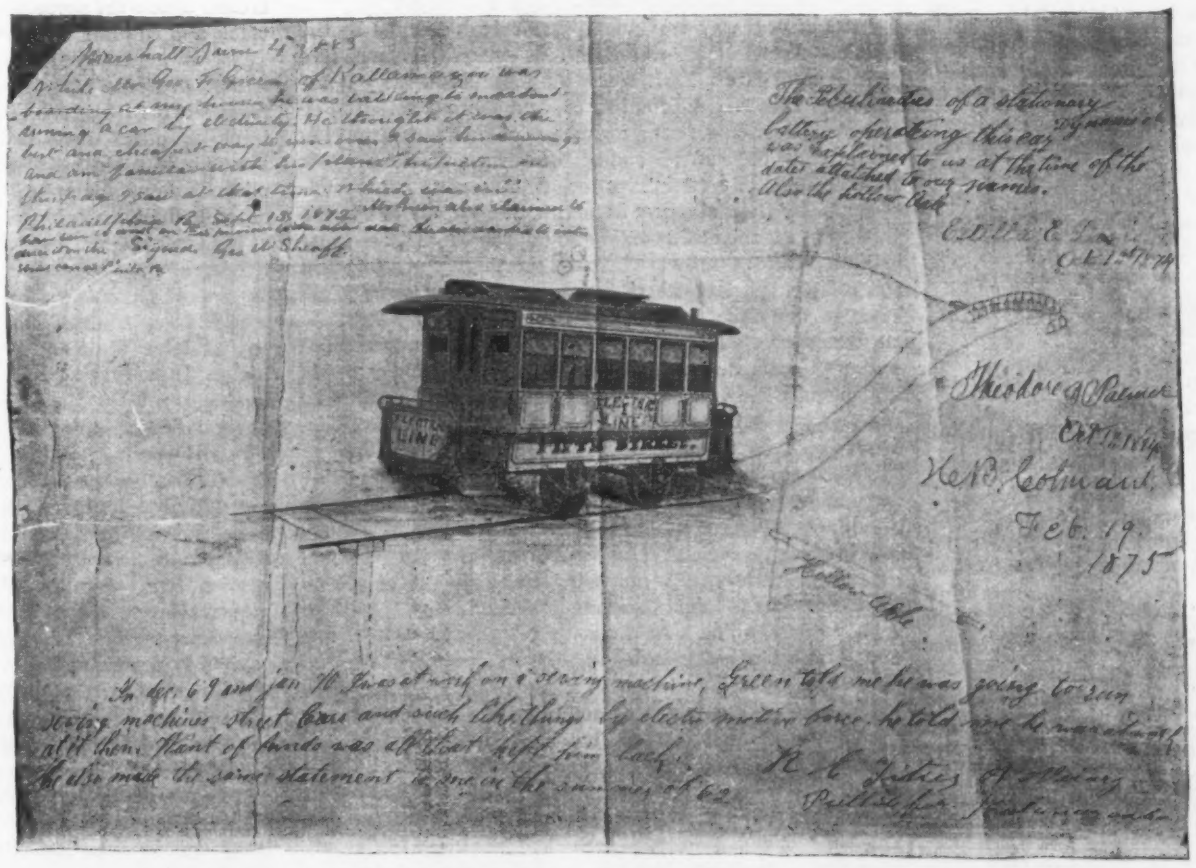
In addition to what has been said here, the official report of the Commission of Experts will add much that is of interest. It will add nothing which will show any shortcomings in the system, or difficulties in carrying it out, which cannot be easily overcome. The report will moreover be an indorsement from the high authorities of men of science, of that which thousands have been able to witness at the Exhibition at Frankfort.

The experiences gained have been such that they form a solid foundation for projecting and designing similar installations and for a basis for future progress.

An Electrical Pioneer.

We have been fortunate in being able to give to our readers this week a portrait of Mr. George F. Green, of Kalamazoo, Mich., whose electric railway patents recently issued have attracted so much attention, as well as a fac-simile reproduction of one of his early drawings, made nearly 20 years ago. This shows in a rough but striking way the system which he intended to employ.

It appears from the history of the case that the invention had long been in Green's mind. His experiments in electrical appliances date back as far as the year 1856; but it was not until 1875 that he produced a little model electric road, notice of which has already been given in our columns. The larger model was not built until 1878 or1879. In the latter year, Aug. 19, this patent was applied for. Although the batteries as a source of power were foremost in his mind even then, to judge at least from the original specification, he clearly appreciated the use of the dynamo in connection with the work.



FAC-SIMILE OF ONE OF GEORGE F. GREEN'S EARLY RAILWAY DRAWINGS.

The principal interference encountered in the Patent Office was, of course, that with Mr. S. D. Field, and the examiners in chief awarded priority to Green, which decision, after various vicissitudes, has been reinforced by the issue of the patent. The litigation in the Patent Office as a whole was particularly severe, the early claims of Pinkus and others being urged by the examiners against Green; and, of course, this ground may after all have to be gone over again before the patent is finally established. But as it stands the issue of that document may be regarded as a victory for a most ingenious and meritorious invention, whatever may be its immediate fate.

Mr. Green furnished the connecting link between the crude early experiments and the modern electric railway. A glance at the original drawing, as shown in fac-simile in our figure, shows, albeit crudely, his intention of using either overhead or rail conductors, although the trolley wire is shown suspended from the bottom instead of the top, as in modern installations. Of the motor system unfortunately no details are given.

The electric railway, like many other important inventions, has been a growth of years, and it is sometimes very difficult to say at what time any given step was taken for every detail. There has been apparently an old suggestion followed by a period of experimentation and the final evolution of a practical form. From an historical as well as

from a legal point of view, the genesis of the modern electric railway is no easy matter to trace. One has to trace its origin in this country back to the root of the period of electrical invention that produced in the hands of Davenport the earliest crude electric railway and from Morse the telegraph.

What were mere suggestions thus grew a decade later to be the experiments, and then came the period of the Civil War, when invention, except in military circles, was almost at a standstill; then the working model of Green, the experiments of Field, and a little later, after the final stimulus had been given by the Siemens electric road in Berlin, the work of a group of modern inventors that has given us now more than 400 electric railways. The ill fortune of Green in the Patent Office unfortunately has kept his labors from the knowledge of the public until very recently, but now that they are clearly seen he should be accorded a worthy place among the electrical pioneers of whom this country has produced so long and noteworthy a line.

The Probable Future of Condensers in Electric Lighting.*

BY JAMES SWINBURNE.

It is always difficult to foretell the future in electrical engineering work, but it is sometimes interesting to try to see in what direction developments are likely to take place.

The first idea of the use of condensers was to employ them like storage batteries, and mention is frequently made by the early electric light patentees of their proposed use in this way. It is needless to remark that these inventors had not the most remote idea of the vast electrostatic capacities needed for storing by the hundred ampère hours.

The project of using condensers instead of transformers is by no means dead. It has been recently taken up on scientific principles by Mr. Doubrava. As soon as a condenser is charged and discharged rapidly enough its size becomes manageable, and Mr. Doubrava is therefore working out a system in which condensers take the place of converters. This development is in good hands, and need not be discussed farther. One great difficulty is in charging condensers with direct currents. A condenser of the capacity of a farad charged with one volt contains, if the expression be allowed, only half a joule. If a condenser is charged by being connected to leads at one volt, half a joule is wasted over resistance and the other half is stored. The only way of charging the condenser without loss is to connect it with an electromotive force which is gradually rising. Similarly, in discharging, the electromotive force must fall gradually. This condition is not at all difficult to attain.

The greatest development of the use of condensers will probably be in connection with alternating currents. It is doubtful whether ingenuity will ever design an arrangement of condensers that will take the place of transformers in practice. In one sense there is better material to work upon. A transformer is always inefficient on account of hysteresis. The loss by "soaking in" may be taken as analogous to the loss by hysteresis, but it is infinitely less in comparison. For instance, a condenser that takes 2,000 volts and 10 ampères has a loss which is too low to measure —that is to say, it is less than five or ten watts. This loss is proportional to the size of the condenser, so that small sizes are just as efficient as large ones. In transformers this is not the case. A 100,000-watt transformer has a loss of somewhat less than 1,000 up to about 5,000 watts, according to the design, and if the 100,000 watts is made up of a number of small transformers the loss is greater.

The uses for condensers are already developing. In the first place, they can be used to supply magnetizing or exciting currents to all sorts of machinery and also to apparatus that takes lagging currents. It must be remembered that the magnetizing current in any receiving apparatus means a demagnetizing current in the generator. As an example that will soon be common, and is also striking, we may take that of running arc lamps off 100-volt circuits with choking coils in series with them. As far as the lamp is concerned there is no better arrangement than running it off a 100-volt circuit, with a choking coil in series with it to reduce the terminal pressure to about 30 volts. If such a lamp takes 10 ampères the apparent power taken is 1,000 watts, but the real power is probably less than 300 watts. The dynamos at the station have thus to supply large "idle" currents. These not only lead to armature heating, but also demand extra excitation. If many arc lamps are used, more dynamos become necessary as no machines will stand three times their normal armature currents, even though they are out of step with the electromotive forces. Such currents, therefore, lessen the plant output, or, as it often loosely called, the "plant efficiency." To overcome this trouble, all that is necessary is to place condensers in shunt to the choking coils and lamps, or in shunt to the high pressure leads. The last arrangement is best, as it admits of arranging the condensers at the central station. In addition to this, condensers for 2,000 or 1,000 volts are easier to make than those for 100 volts. Condensers for such low pressures cost too much in tinfoil, and are somewhat bulky, because the dielectric has to be made thick in proportion, to make certain of the absence of flaws. At present comparatively few arc lamps are run in this manner, but that is because nearly all the alternating current systems now in use have small transformers in houses and high pressure mains about the streets. This barbarous custom is rapidly going out of fashion. It has taken people a long time to realize that there is an appreciable waste of power in house transformers, and high efficiencies were always quoted, the losses in the copper alone being considered. The loss in iron is more generally understood now, and the substation system is coming into use. This involves automatic gear, and, though certainly an improvement on the old methods, is hardly likely to live long. The system of avoiding loss by automatic gear is bound to go as soon as makers alter their designs and make their transformers more efficient at light loads. The feeder system will then prevail. A high pressure feeder will then have a transformer at the other end feeding into a low pressure network. The transformer will have so little loss that it will not be worth while to switch it out of circuit during the day. Even if automatic gear is used, it is not necessary to employ a complicated system of switches. An automatic switch in the secondary, which is controlled by the current in the primary, is all that is required. On breaking the primary circuit at the station, the switch opens the secondary. On making the primary, the secondary makes itself. Whichever method comes into use, it is probable that arc lights will be run off 100-volt circuits with choking coils and condensers will be required at the stations. Of course there is no reason why arc lights should not be run off high pressure circuits by means of constant current transformers. This system has never come into use in this country, probably because the low cost is not generally appreciated.

It may be well to give some idea of the size of a condenser. One cubic foot of a condenser will take about 2,000 volts and five ampères, or 10,000 apparent watts. With higher pressure the volume necessary is slightly less, and with low pressures the size increases Below about 500 volts the bulk increases rapidly, as the volume of tinfoil is greater. The cost, therefore, increases too. It is possible to make condensers very much smaller than this; but while they are new it is best to allow a large factor of safety. Choking coils and constant current transformers for arc lamps are not the only things requiring exciting currents. Transformers, especially if made with open iron circuits, take "idle" currents, and this can be supplied in the same way. Nearly the whole of an open circuit exciting current can be supplied by condensers There is always some left over, because the electromotive force never varies exactly harmonically. Even if it did, there is some loss in the iron, so the no load current cannot be reduced to nothing. In a closed circuit transformer the no load current is less to begin with, but the active component is much greater, so that it cannot be reduced so much by condensers. It can generally be halved.

* From *Industries*.

The Application of Electricity to Block Signaling.

Safety in railway travel is imperiously demanded by the public. Accidents like the disastrous one on Christmas Eve just out of New York force the sins of railway management into vivid prominence and compel action to be taken at once to prevent a recurrence of such a catastrophe. In the early days of railroading safety appliances were few and methods of communication from station were conspicuous by their absence; in fact, it was largely due to the invention of the electromagnetic telegraph that the great growth of steam railways became thoroughly possible and practicable. Strange as it may seem it took some little time to convince the railway managers of that day that the telegraph could be depended upon, that it was feasible and of direct benefit in facilitating the dispatching of trains and untying the various tangles which were bound to be encountered in railway operations. Of late this same sentiment has been transferred to the beautiful applications of electricity to steam railways for insuring the safe operation of trains. It is an unreasonable prejudice, bound to be dissipated in the course of time, but still, even now, altogether too prevalent. To secure immunity against accidents on railways it is necessary, first, that the track be kept in repair to avoid derailment; second, that it and the rolling stock should be periodically inspected. When this is done there is a reasonable security against accidents due to encounters of the train with extraneous obstacles. The principal danger comes from collisions with other trains on the same track. When a road is double tracked throughout, unless by extraordinary carelessness of switchmen, head end collisions are almost out of the question. But we must remember that a large part of the roads in this country are single track roads and will long continue so to be. There is, therefore, double necessity for precautions. Even on double track roads the most fruitful source of danger still remains—the much dreaded rear end collision, uniformly more horrible in its effects than any head end collision ever could be. The catalogue of catastrophes of this sort is a long and dreadful one and will add to its dismal bulk until all the railroads are properly protected.

For many years the block signal system has been growing in use here and abroad. A large part of the English and continental lines are now so equipped, and in our own country the number of applications is constantly increasing. In a general way one may describe a block system for railroads as a division of the track into sections, and the displaying of danger signals at the beginning of each section unless it is entirely free and clear of obstacles. In its most rigid and refined form the block system is absolute, no train being allowed to enter any section of track unless it is perfectly clear. Necessities sometimes arise for modifying this so as to permit the entrance of other trains, but only when running with extreme caution. Broadly speaking one may safely assert that every and any block signal system must depend on electricity for its successful operation, as, unless the sections guarded were so short as to be always visible from each other, some means of transmitting intelligence and signals, even if the system be not automatic, must be provided from one section to the next. In any block system at every point where two sections join a system of signals of some kind is in operation. It may consist of a series of houses with watchful signal men to warn incoming trains of the state of the road in front, and from this it may pass through every degree of mechanical elaboration up to perfect automatism. Electricity may simply serve to transmit intelligence, to put various mechanical appliances into operation, or to actuate directly the signals themselves.

We may thus in a general way say that there are three classes of electric block signals: first, those where the actual operation of the signals is done by hand and electricity is used merely for sending the requisite messages with proper safety devices to see that they are not misunderstood; second, where it is employed to actuate mechanical powers placed at a distant point; and third, where it is responsible for the whole operation of the system. These general appliances are subject to numberless modifications and are worthy of some study.

It is impossible in any limited space to attempt a complete account of the various plans that have been proposed or used; it will suffice, therefore, to give the reader a clear idea of the fundamental principles of a type of each of these three distinct kinds of electric block signals.

In the first place we may consider those systems wherein the actual precautions for safety are taken by signal men stationed at the appropriate points. In its various forms this plan is very widely used, almost universally in England and on the continent, very widely by the Pennsylvania Railroad and others in this country, and on a short section of the New York Central road—unfortunately not extensive enough to have prevented disaster. In a general way it is constituted as follows: at the beginning of each section is a signal house with a watchman, whose duty it is to set danger signals whenever any train is upon his section, to warn any train that may follow, either to stop until the section is clear, or, after a pause, to proceed forward with the extremest caution. Such is the Sykes system, used so extensively abroad and considerably in this country. The signal houses are connected by telegraph, and, in addition, there is a special electrical connection between them by which it is impossible for any signal man to show to an incoming train a signal that the track ahead is clear unless the preceding train is actually entirely off the track and running through the section next ahead of it. This is generally accomplished by an electrical lock which prevents the lever that actuates the signal from being thrown so as to show that the track is clear until it is set free by the entrance of the train into the next section ahead. This end is accomplished in a very simple manner. An electric circuit is established including a locking device and the short length of track at the beginning of the section ahead. A train passing over this bit of track short circuits the battery connected with it and sets the lock on the signal lever at the other end of the section free. On this the signalman may know that his entire section is clear and can manipulate his signals accordingly. If everything is in normal working order he will be unable to remove the danger signal until the train is entirely over his section.

It will be observed that such a block signal necessitates a signal house for each section and depends to a considerable extent on human intelligence and watchfulness for its proper operation. It is, however, very efficient, and has served an immensely useful purpose in reducing the danger of accidents. A desire, however, to eliminate the unpleasant factor of human fallibility that necessarily enters into its operation has caused inventors to seek a system equally or more effective, and as far as possible free from the danger of negligence on the part of signalmen.

Many very ingenious solutions to the difficulty have been proposed, the first of which to be considered will be a type of electric block signal system that employs electricity not merely for signaling purposes but to actuate mechanical devices at points along the line. The system to be particularly described is that of the Union Switch and Signal Company, which has been extensively adopted on American roads, especially in yards and at other points where considerable complication of switches is necessary. The principles employed are exceedingly simple. The switches and signals on the line to be protected are actuated not by hand but by compressed air, and the air valves are operated by electric circuits controlled from the signal houses.

The plant of this system which controls the great yard of the Pennsylvania Railroad in Jersey City is an interesting study. In the signal house a single man watches the orderly complication of switches and controls every switch and signal in his section. Before the operator and rising above the table where the series of switches is located, rises a mechanical map of the tracks controlled, so connected to the electric switches that the throwing of any one of them shifts at the same time a switch in the yard

and one in the model, so that the operator's eye can follow out the line in front of an incoming or outgoing train and see that every switch is in its proper position.

Figs. 2 and 4 give an admirable idea of the apparatus by which so successful a control of the tracks is obtained. At each signal post is placed an air cylinder which actuates the signals and controls in its turn an electric valve. A glance at the cut will show the details of the arrangement

An ironclad electromagnet with a disc armature—shown at the upper end of the cut—controls a minute valve which admits compressed air to the working cylinder and operates the signal. The little valve is in fact a double one, governing both the exhaust and admission. Fig. 2 shows the switch instrument, and the first glance will show that it consists of a double cylinder working on the same principles. The air pressure employed is from 60 to 80 pounds, amply sufficient to throw the switch under any circumstances. The circuit is normally closed on one or the other of the magnets all the time, thus holding the switch in position at either side, as the air keeps the piston over its position. In addition the central magnet of the figure provides a lock to hold the valves in their proper position. When it is desired to throw the switch a commutator in the signal tower is turned, the first action being to break circuit on the magnet at the then working end of the cylinder, then to withdraw the lock through the medium of the central magnet and make circuit on the other side, opening by the valve piston the air valve and thus throwing the piston. Finally the locking magnet is raised and the bolt flies into place, holding the switch in its new position. A number of very ingenious details are provided to secure double safeguards and facilitate the general operation of the system. Among these may be mentioned automatic locking devices for signals, so arranged as to hold the appropriate switch in the station until the signal has gone into its proper position. This is accomplished by extra contacts attached to the signal instrument and closed by a piston in its movement. Another neat device is automatic signaling in the station.

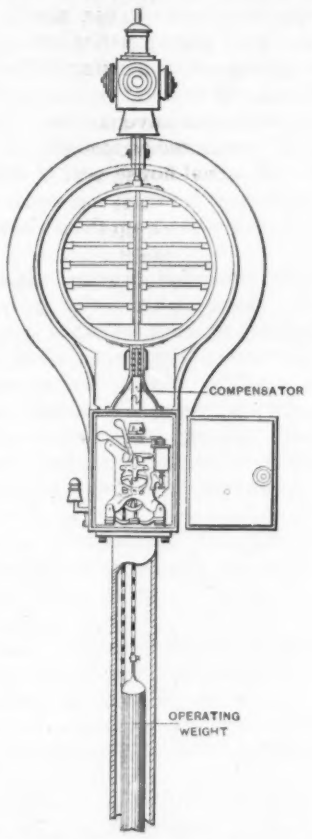


FIG. 1.—ELECTRO-MECHANICAL BLOCK SIGNAL.

A section of track is insulated and made part of a circuit which passes through a relay, and there operates a circuit to work the signal mechanism. The current is normally flowing through a relay, but when a train enters the station and gets on the insulated track the relay is short circuited and the signal automatically set to show that the track is occupied. The system throughout is to hold the signals normally clear except when the train is in a position which requires that it be set to danger. The apparatus is so arranged, however, that on any failure in operations through leaks, or other causes, the pneumatic system will allow the signals to go to danger as they are held clear in opposition to the force of gravity and a considerable weight at that. This pneumatic system is particularly valuable and important in the operation of the immense complication of signals and switches in yards, whether it or some other system is used for the block signals upon the whole line of the track. For example Mr. Chauncey M. Depew in a letter to the Railway Commissioners advocates the use of this system at and about stations in connection with the Sykes along certain portions of the line. The motive of such change of system is probably economy, as the objections to any system which depends on the fidelity of a large number of signalmen have already been stated. This same short circuiting device employed in the station and in the Sykes system for operating the safety locking device has also been applied by the Union Switch and Signal Company to a mechanical block signal in use on several roads in New England and to general block signal work as shown in Fig. 3. In this case the block signals are driven by heavy weights running in the signal posts, and wound up daily when the lamps are lighted. The operation—by a train passing on to the block—is much on the same principle as that already described. Fig. 1 shows the signal post. In the simplest form of the system one signal passes to danger as a train enters each section, and is kept at danger until the train is out, but this has been found not always to be sufficient, so a method

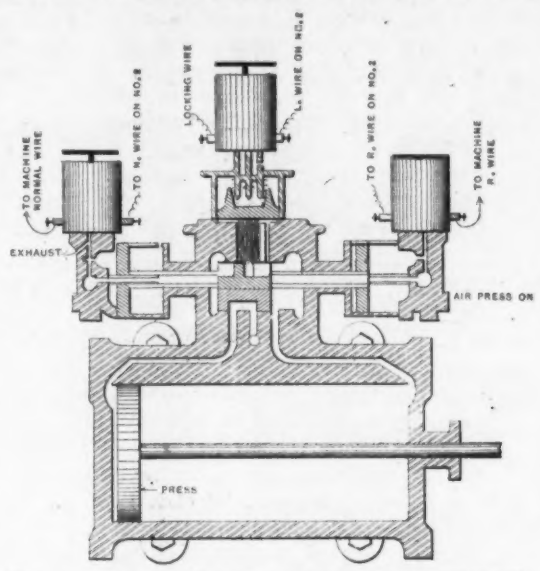


FIG. 2.—ELECTRO-PNEUMATIC SWITCH CONTROLLER.

of overlapping signal sections has been adopted, so that two or more—according to the position of the train—may be kept at danger until the train passes to the next section. The signals in this arrangement are immediately thrown to danger in case the controlling or actuating powers should be disarranged.

In a third class of block signals, represented at present by only a single type, electricity is used not only automatically to signal, but actually to operate the signals themselves. In this field the Hall Signal Company is the pioneer, and its system has already been adopted on a portion of the New York Central road, that from Oscawana to Peekskill, where the blocks are 3,000 feet apart. In the earlier stages of its development the Hall signal system employed a wire circuit along the track, connecting to switch or signal instruments, which were operated by the passage of a train, the tread of the wheels striking a lever close along the track and working the contacts. This system has already been fully described in THE ELECTRICAL WORLD,* but has been abandoned for the regular block system work, although retained for working isolated signals, crossing bells and similar apparatus. The fundamental principle that characterizes the electrically actuated signal post is the use of completely covered signals, all the moving parts being shut in a case, and the red and white discs exposed behind a glass covered opening as occasion requires. By this casing all the working parts are completely protected from the weather, and it is possible to operate them much more easily, and to avoid all danger of their proper action being interrupted by snow or sleet. They are of ample size to be readily seen, and have proved to be every bit as efficient as

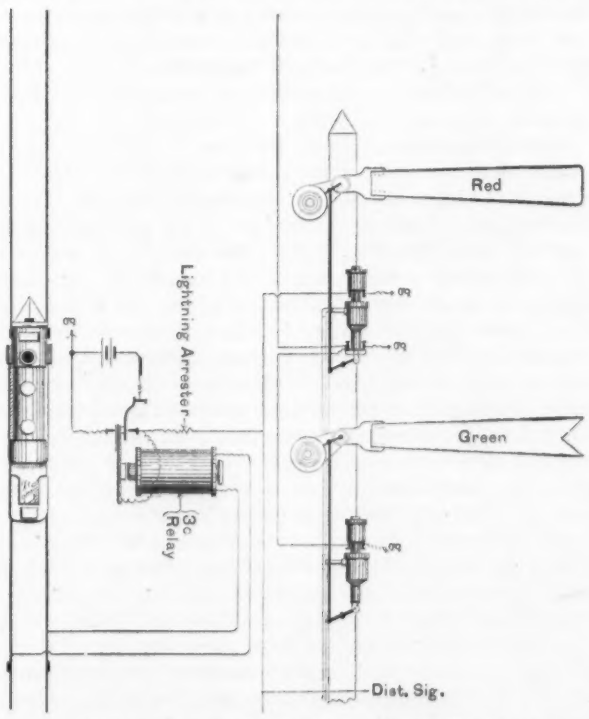


FIG. 3.—DIAGRAM OF TRACK CONNECTIONS.

the types of signal posts more generally employed. The operating mechanism at the signal post is substantially that described in the article just referred to. It is very simple, a single electromagnet being arranged to give a long and a strong pull, as long as the current is passed through it holding the signal in position. In the latest form of the Hall signal system the methods employed are particularly simple. The track is divided into sections a mile or so in length, insulated from each other, the rails are bonded to form the rail circuit, much as the electric railway rails are bonded; two cells of gravity battery are connected with the track circuit through a relay which actuates the local circuit controlling the signal.

This system carries out the cardinal principle of the English block in any form, whether of the Sykes, Bezer or any other pattern, that the signal shall stand normally and usually at danger, and shall be cleared only as the train approaches it, provided, of course, that the block which the signal protects is free of trains or other obstructions. This prevents absolutely a train entering a section already occupied by another train, a detached car, open switch or broken rail.

As a double safeguard, "distant" signals are provided, which warn the engineer ahead of time what the signal he is to be governed by indicates, thus allowing him sufficient time to stop his train. It can be operated, however, without the "distant" signals.

Then, again, many improvements have been made in the new Hall system over that previously employed. The old disc signal was objected to on account of its indistinctiveness. This was largely owing to the fading of the signal discs and neglect of the maintenance corps to renew them at regular intervals. The red discs are now manufactured of a specially dyed material that is guaranteed to be nonfading. The green discs for the distant signals are constructed of standard flag green bunting of fast colors. The opening in the case has been enlarged, so that the form of the signal as well as the color are more visible. The illumination of the disc for a night signal has been dispensed with, and a standard semaphore lamp with red and green lenses, for home and distant signals, has been substituted therefor.

We may trace the development of electricity in the applications of block signaling through every stage from a mere modification of train telegraphy up to this wholly electric system which eliminates from the problem of safe train service all human sources of error except the engineer, on whom finally must always fall the burden of the safe conduct of his train.

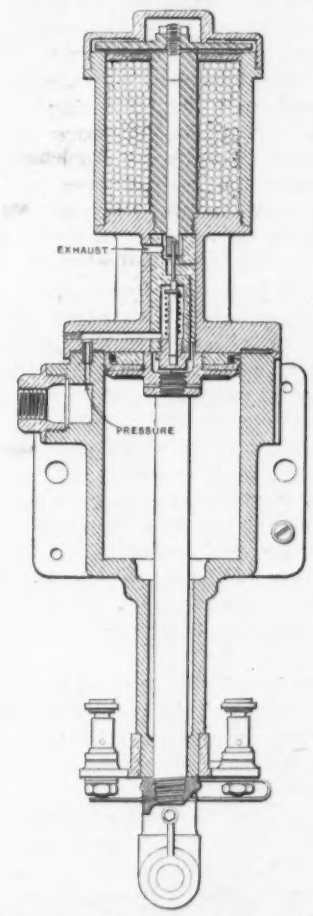


FIG. 4.—ELECTRO-PNEUMATIC SIGNAL CONTROLLER.

A Neat Rotary Current Experiment.

At the last meeting of the Physical Society of London, Prof. Ayrton read a note on "Rotary Currents." Alternate currents, he said, it was well known could be obtained from ordinary continous current dynamos by making suitable contacts, and a continuous current motor similarly treated transformed continuous currents into alternate currents or into mechanical power. If two pairs of points in the armature be selected at opposite ends of two perpendicular diameters, then two alternate currents differing in phase by 90 degrees could be obtained, and by choosing suitable points in the armature, two, three, or more currents differing in phase by any desired amount could be produced. The connections for doing this would be somewhat troublesome, but the Ayrton & Perry motor, which has a stationary armature, lends itself readily to this purpose. Prof. Ayrton showed one of his motors in which contact was made with four equidistant points on the armature on connecting opposite points with fine platinum wires and running the motor slowly, the wires glowed alternately, the one being bright while the other was dark and *vice versa*; a pretty ocular demonstration of two currents in quadrature. When four points on the armature were joined to the four corners of a square of platinum wire, the wires became incandescent in succession, the glow appearing to travel round the square and suggesting the idea of a rotary current.

* THE ELECTRICAL WORLD, July 5, 1890.

Elements of Practical Electricity.*

BY DR. LOUIS BELL.

Suppose we were to have a wire, *A B*, Fig. 31, stretched obliquely downward through a small tank of water, so arranged that the rate at which heat was given out by the wire could be measured, and suppose that we found its rate to be for the whole length of the wire *A B* four watts. we should then be sure that the difference in electrical pressure between *A* and *B* amounted to four volts. The wire is supposed to be of uniform diameter and homogeneous material, so that its resistance throughout is uniform, then if our wire were a foot in length we should have one watt given out for each six inches of its length and one volt difference of potential for each six inches. For example, if the difference in pressure from *A* to *B* is four volts, from *C* to *B* it is three volts, from *E B* two volts and from *G* to *B* one volt. In other words if the wire is uniform the fall in potential is also uniform, and if we know the total difference of potential between the two ends each inch of length will be a proportionate amountof this total length.

We may use Fig. 31, however, in a very much more general way than simply to represent our particular wire, for if we have any wire whatever, *A B*, with any difference of potential between its ends and make it follow the hypothenuse of a right angled triangle on any scale we like, one inch to a foot for example, making a perpendicular *O A* of such length, so as to represent on the same scale, for instance, the total fall of potential through the wire in volts, then if we drop at any one point, *C*, for example, the perpendicular *C D* on to the base of the triangle, its length will represent on our scale of volts the exact difference of potential between *C* and *B*, and so on for any number of points we care to choose. This is really just as we had good enough right to anticipate, for since the same current flows through the entire length the work ought to be a uniform amount per inch of length, and hence the fall of potential should also be uniform as it is.

We now, however, come to the idea of electrical resistance in its relation to current and electromotive force.

You have already seen that by putting more or less resistance in the circuit of a battery the current can be varied very widely. The electromotive force of a battery, that is the difference of potential between its terminals, is practically unchanged, but is able to force a greater or less amount of current along the wires according to the resistance. Now it is of the utmost importance not only to be able to express varying resistance in terms of some unit systematically connected with those we have already employed, but that we should further be able to know the relation between the electromotive force and the current that it is able to force through a particular resistance. The practical unit of resistance has been determined with reference to the other factors with which it is connected—the current and the electromotive force—and the unit of resistance is of such a value that under an electrical pressure of one volt, one ampère will flow through it. This unit of resistance is called the "*ohm*," and has often been defined in terms of a certain particular length of wire of a given diameter and material, inasmuch as the resistance of such a wire, if its temperature is constant, is very nearly uniform under all conditions.

The ohm, then, is really determined by reference to the volt and the ampère, and the process of determining its true value depends on measuring by independent means the current and the electromotive force with reference to some particular material resistance, such as a wire. It happens that very small impurities in metals cause large variations in the electrical resistance, and, further, that differences of mechanical treatment, such as hammering, drawing and annealing also produce considerable differences in resistance. So it is necessary, in making a standard of resistance by any such direct process of comparison with the electromotive force of the current—as I have before indicated—to employ for that resistance some material which can be easily obtained in a very pure state, and is quite independent of the way it is mechanically treated.

If it were possible to say that 100 feet of copper wire of a certain diameter would always have a resistance of one ohm, it would be very convenient, for we then should be able to cut off any number of such pieces and have them always at hand. Inasmuch as we cannot be sure that two pieces of copper wire of the particular size specified, cut off by different people at different places, would ever have the same resistance, the necessity just mentioned of a material which can always be depended upon is evident. Such a material is found in mercury, the only one of the pure metals that is liquid at ordinary temperatures. Being liquid, it is not subject to the variations in resistance produced by mechanical processes, and, furthermore, it is very readily obtained in a state of almost perfect purity, inasmuch as it can be distilled, just as water is distilled, but at a somewhat higher temperature. It only becomes necessary to enclose it in a glass tube of known diameter to become possessed of a liquid wire of perfectly pure material, and in uniform mechanical condition wherever and by whomever it is constructed.

The ohm, by direct comparison between current produced and the electromotive force producing it, has been found to be equal to the resistance of such a wire of mercury just one square millimetre in section, and 106.3 centimetres long, at the temperature of melting ice. The temperature has to be specified because the resistance of the material varies somewhat with the temperature, in most cases increasing as the substance grows warmer.

Now there are very accurate methods, which I will presently describe, for comparing two resistances, and if we have constructed a mercury resistance of specified dimensions, we can then make a precisely equal resistance of wire which will be much more convenient for general use, and this wire resistance will remain to all intents and purposes constant in amount unless it is subjected to very rough treatment.

With respect to copper wire, two facts easily remembered will lead to a very convenient appreciation of its actual resistance. One thousand feet of No. 10 copper wire, one-tenth of an inch in diameter, has a resistance of just one ohm; 250 feet of No. 16 copper wire, which is very nearly one-twentieth of an inch in diameter, also has a resistance of one ohm. So much for the unit of resistance and its value.

Now for the more important fact of its exact relation to the current and electromotive force. There is one law on this subject which has been so often experimentally verified and so thoroughly studied in all its relations that we can place the utmost reliance upon it. Experimentally it is based on the fact that when any conductor is taken and the difference of potential between its ends is measured in volts this difference of potential divided by the current in ampères gives a numerical quantity which does not vary as the strength of the current varies. For example, with double the current there is double the difference of potential; with half the current, half the difference of potential; the ratio being the same in each case. This ratio is our resistance, and the whole matter may be summed up by a simple expression of the experimental fact that measuring the electromotive force in volts and the resistance in ohms, the current in ampères equals the electromotive force divided by the resistance, which is expressed in the rudimentary algebraic form $C = \frac{E}{R}$. This is known—from the man who first experimentally demonstrated the fact—as Ohm's law. Simple as it is, it can be used in an infinite variety of ways. For example, what is the resistance of a wire through which three ampères passes, propelled by an electromotive force of seven volts? We then have $3\ R = 7$, that is three times R equals seven and R equals 2 1-3 ohms.

On the other hand, suppose we wish to know what current an electromotive force of 11 volts will force through a resistance of six ohms, simply writing 11 and 6 instead of E and R we see that the required current equals $1\frac{5}{6}$ ampères. And again, we may desire to know what difference of potential exists between the ends of a wire, which has a resistance of say five ohms, and through which a current of eight ampères is flowing. We may then for convenience transpose the form of Ohm's law given above, and write it $C \times R = E$, therefore the difference in potential we wish to find is $= 5 \times 8 = 40$ volts.

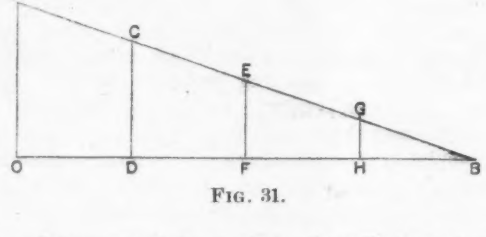


Fig. 31.

These three ways of using Ohm's law can be, and are, continually employed in the solution of various practical problems, and you should set for yourself and work out various applications of the law until you get thoroughly familiar with its use. For example, suppose you desire to supply current for 20 incandescent lamps at a distance of 500 feet, they are to be run on a 110-volt circuit, and you are willing to allow five volts drop of potential in the wires that go to your group of lamps. The voltage of the circuit does not enter the problem except as it indirectly regulates the amount of current that is required for each lamp; 110 volts requires about .6 of an ampère.

The method of solving the problem of finding the size of the wire you must employ is as follows: There are 20 lamps, each requiring .6 of an ampère, therefore the total current to be sent over the line is 12 ampères. The total length of wire to the lamps and back is 1,000 feet. The conditions that you have set stipulate, then, that the drop in potential for 1,000 feet on wire carrying 12 ampères shall be five volts, required the resistance of the wire. Since $C \times R = E$ this gives a difference of potential between the ends of the wire $R = E \div C$; or, substituting the values of C and E, which you have just found, $R = 5 \div 11 = .417$ ohm, which is the double resistance of the 1,000 feet of wire, which will transmit 12 ampères, with the given drop of potential.

Now turn to any convenient table of dimensions and resistances of wires, such as can be found in the catalogues of any wiring manufacturers' and electrical supply houses. They give, as a rule, the gauge, area and diameter of the wire, the resistance per thousand feet, and the carrying capacity of the wire in ampères. In other words, the amount it will carry without the amount of energy spent in the wire being so great as to heat it severely. Taking such a table, you will find that the size of wire the resistance of which per 1,000 feet comes closest to the value you have found is No. 6 B. & S. gauge, which should consequently be used in making such an installation.

In the same way you can find the size of wire required for any other wiring problem that you may encounter. In such cases you have to deal with the allowable drop of potential and the current that must be transmitted; from these two you can always find the permissible resistance of the wire, and then by reference to wire tables the corresponding size, for any similar problem. Suppose you want to place 40 50-volt lamps, which require about an ampère each, at a distance of 100 feet, with a drop of only one volt. A similar computation to the last gives you $R = 1 \div 40 = .025$ of an ohm. This is for 100 feet distance from the source of electricity, and the total length is 200 feet. The resistance of the proper wire, then, per 1,000 feet must be .125 of an ohm. Looking this up as before, we find the nearest size of wire to be No. 1 B. & S., which is the size to use in such a case.

You will do well to practice on these problems until you get thoroughly familiar with the application of Ohm's law. The three forms in which it appears are as follows:

$$C = \frac{E}{R}$$

$$E = CR$$

$$R = \frac{E}{C}$$

Knowing two of the quantities concerned in each of these equations, you can always find the other by the simplest sort of computation, simply substituting the values, and, if necessary, reducing the resulting fraction to a decimal for convenience.

One point may be mentioned, connecting Ohm's law with the work done in the circuit. We have already seen that the way in which we have determined the electromotive force was with reference to the work done in the circuit, and that the rate of work in watts always equaled the volts multiplied by the ampères. In other words W (the watts) $= E\,C$. It is sometimes convenient to know the work expended in the wire in terms of its resistance and the current. Now, since $E = C\,R$, as we have just seen above, we can use our last expression in the form of $W = C\ R \times C$, that is, $W = C^2R$, which is the measure of the work done by any current through a circuit of any resistance; it turns up as heat in the conductor. This last equation is what one would naturally use, for example, in finding out the losses that occur in the armature of a motor or dynamo by noting the resistance of the current that flows through it.

The work lost in this way in a large measure determines the efficiency and can thus be found at once. The only special precaution that must be taken in applying Ohm's law to finding the size of wire required for a given case is that at no time must the current be so large as to heat the wire, and thereby increase its resistance, so as to vitiate your calculations. So long as the wire remains nearly at the temperature of the surrounding air you are safe, however, and you may always be guided by the safe carrying capacities of the various sizes of wire, which must not be exceeded and should not be approached very nearly if you are attempting any fine adjustment of the drop in potential.

For convenience a table is appended giving the gauges, the corresponding diameters in one thousandths of an inch called, generally, mils, the area in circular mils—that is the area as compared with a circle one one-thousandth of an inch in diameter, the resistance in ohms per thousand feet, and the safe carrying capacity.

American gauge, Brown & Sharpe's number.	Diameter, mils.	Circular mils 1 mil = .001 inch.	R. ohms per 1,000 feet.	No. Ampères.
0000	460.000	211,600.00	.0490	175
000	409.640	167,805.00	.0618	145
00	364.800	133,079.40	.0780	120
0	324.950	105,592.50	.0983	100
1	289.300	83,694.20	.1240	95
2	257.630	66,373.00	.1564	70
3	229.420	52,634.00	.1972	60
4	204.310	41,742.00	.2486	50
5	181.940	33,102.00	.3136	45
6	162.020	26,250.50	.3954	35
7	144.280	20,816.00	.4987	30
8	128.490	16,509.00	.6288	24
9	114.430	13,594.00	.7928	20
10	101.890	10,381.00	1.	17
11	90.742	8,234.00	1.2607	15
12	80.808	6,529.90	1.5898	13
13	71.961	5,178.40	2.0047	10
14	64.084	4,106.80	2.5908	8
15	57.068	3,256.7	3.1150	5.5
16	50.820	2,582 9	4.0191	5
17	45.257	2,048.2	5.0683	4
18	40.303	1,624.3	6.3911	3.5
19	35.390	1,252 4	8.2889	3
20	31.961	1,021.5	10.163	2.5

(To be continued.)

Magnetic Properties of Liquid Oxygen.

Prof. Dewar in a recent communication to the Royal Society gave the results of his investigations to determine what effect a temperature of 180 degrees C. would have upon the behavior of liquid oxygen in the magnetic field. Having previously ascertained that liquid oxygen does not moisten or adhere to rock crystal, and consequently maintains in contact with that substance a perfect spheroidal condition, he poured the liquefied gas into a shallow saucer of rock crystal, and placed it between the poles of the Faraday electromagnet. On the magnet being excited, the whole mass of liquid adhered to the poles until dissipated.

* Continued from The Electrical World, Jan. 2, 1892.

Notes on the Frankfort Electrical Exhibition.*

BY CARL HERING.

The list of the international electrical exhibitions which have been held so far begins with the one in Paris in 1881; this was followed by the one in Munich in 1882, then in Vienna in 1883, and Philadelphia in 1884, which was the last of this annual series of exhibitions. After a lapse of five years, during which time there were none of importance, it was followed by the Universal Exhibition in Paris, in 1889. Although this was not an electrical exhibition, the electrical exhibits formed such a large and important part that they may well be said to have formed the equivalent of an electrical exhibition. This was followed by the one at Frankfort held this year, which forms the sixth and last, and which is to be followed by the electrical section of the World's Fair in 1893, making the seventh. Among the electrical exhibits made at exhibitions prior to the Paris Exposition of 1881 may be noted the first exhibit of the telephone, and a few arc lights run with a Gramme dynamo, both at the Centennial Exhibition in Philadelphia, in 1876. Also a very small electrical exhibit, chiefly of telegraph instruments and apparatus, at the Paris Universal Exhibition of 1878.

The most prominent features at the electric exhibitions were as follows: In the first one at Paris, in 1881, the chief feature was what might be called the birth of the present electrical industry. The most prominent exhibits included large dynamos of proportions thus far unknown; practical systems of distribution of arc lamps in series and incandescent lamps in multiple arc, and practical systems of telephonic distribution. In Munich the most prominent feature was the electrical transmission of power, about which so much was written, though so little was accomplished. In Vienna, in 1883, and in Philadelphia, in 1884, there were no particularly prominent features, electrical engineering having by that time developed into a steadily growing industry, as distinguished from one developing with spasmodic strides as in the previous years. In Paris, in 1889, the prominent feature ought to have been alternating current distribution, but owing probably to the absence of certain American and Austrian exhibitors such systems were not as prominent there as their importance and their development at that time would have warranted. The alternating current apparatus of Prof. Thomson and his welding machinery were unquestionably the most interesting and novel features at this exhibition. At the Frankfort Exhibition, the most prominent feature was very high tension alternating current transmission and alternating current motors. What the World's Fair has in store for us is to be seen, but electrical traction will doubtless be among the most prominent of the later developments in the electrical industry.

The two exhibitions in Paris were truly international in character, but in the others, except perhaps in the one at Vienna, there were so few exhibits from foreign nations, that they can hardly claim to have been more than national exhibitions.

International electrical congresses were held in Paris in 1881 and 1889, in Philadelphia in 1884, and in Frankfort in 1891; of these, the first did the very creditable work of laying down the admirable system of electrical units and names, which stands to day as the most simple, rational and uniform system of complex units of measurement existing in any branch of engineering. The third congress, in 1889, also did good work in the field. The one in Philadelphia in 1884, and in Frankfort this year, accomplished practically no international work, leaving all the more to be done at the fifth congress to be held in Chicago, in 1893.

The Frankfort Electrical Exhibition was started, I understand, by the Electrical Scciety of that city; it was conducted by some of the leading business men and electricians of that city, and I believe with some assistance or recognition from the government. It was therefore more of a private rather than a national enterprise. In Frankfort the foreign exhibits were limited to a very few, chiefly from Switzerland, England and the United States; it cannot, therefore, lay much claim to having been international; it certainly was not, so far as representing the state of the art in other countries was concerned. It was an excellent exhibition of the state of the industry in Germany, but that was all.

The general arrangement of the grounds, buildings and exhibits was very creditable. The grounds and most of the buildings were attractively arranged with a view to giving it a pleasing appearance and making it an attractive resort for the public, with as many "side shows" as possible, for which, however, an extra admission was charged. The average price of admission being only 18 cents, and on Sundays five cents, it was visited largely by persons who came there for amusement more than for studying the exhibits. I mention this because without these attractive features it could not have been a financial success. The number of visitors during the six months was somewhat over a million. The attraction afforded by some of the "side shows" may be judged from the fact that of the visitors at the exhibition one out of every three visited the panorama, a painting of a transatlantic steamer entering New York Harbor. The only electrical feature about it was that in the evening it was lighted by electricity.

Among the popular attractions on the grounds may be mentioned the following: A moderate sized theatre with electric illumination from accumulators and a very complete system for manipulating the lights to produce stage effects. Popular and very fully illustrated lectures were given here every afternoon, while in the evening there was a performance consisting of a pantomine or ballet in which the plot was a senseless though otherwise amusing mixture of mythology and of the history of electricity from the frog experiments to the crowning glories of the electric light. In a miniature model theatre the firm of Siemens & Halske exhibited a very complete system of stage illumination, capable of producing very varied and really beautiful stage effects. This exhibit was a very successful one and leaves no doubt that electric light is not only the best, but also the only means for producing such fine illumination effects on the stage. Many of these effects could not have been produced with gas or calcium lights, not to speak of the danger of fire attending such an attempt. The imitation of the sunset, the alpine glow and the rising of the moon were particularly fine, and in some respects fully equaled those of nature.

On the grounds was an artificial waterfall pumped electrically from the river, with both direct and alternating current motors, and illuminated internally and externally with hidden colored electric lights. The internal illumination was not a success, as had been demonstrated before, both at Paris in 1889, and at Philadelphia in 1884, but the external illumination was quite fine and attractive, though hardly comparable with the really beautiful effects produced in the illuminated fountains in Paris in 1889, by an English firm. The total illumination of the grounds and buildings was somewhat over a million candles. In the telephone building there was a long distance transmission from the opera house at Munich, a distance of about 200 miles. Male and female voices could be distinguished from each other, and sometimes even the different instruments of the orchestra. Beside this long distance transmission there were also several others from musical halls and theatres in the environs, in which the transmissions were very good.

Among the minor popular attractions were the following: A diver working under water by electric light; a sort of artificial racecourse for children, in which each horse was operated by a separate motor under the track operated from a common platform; an artificial mine, under ground, with mining ventilators and a small railroad; electric elevators, railroads and launches, etc.; a boat with a benzine engine, both made entirely of aluminium produced by an electric process. One of the attractions greatly appreciated by the public was not electrical at all, being a series of workshops in active operation, for the manufacture of goods of all kinds, in which the only electric feature was that the machinery was driven by electric motors.

These popular exhibits, together with two typical German attractions, viz., excellent music and the numerous "Bier Hallen," formed the chief features for the public. On the other hand, the exhibition was by no means without attractions for the electrical engineer. The exhibits which interested him far outnumbered those for the public. It may be said, however, that with the exception of a few exhibits, there was little shown which was not already known to the engineer through the foreign and domestic electrical journals. In these days of enterprising journalism there is probably little of novelty in the electrical industry which does not find its way into the journals. The electrical journals of to-day may be said to form our permanent electrical exhibition. Although most of the exhibits were already known to the engineer through their published description, it was nevertheless very interesting to see them and examine them in operation. It was in this feature that the exhibition was most interesting to the engineer, and for this reason a description such as could be given here is a poor substitute for a visit to the exhibition itself. I will therefore confine myself here merely to some general statements, leaving detailed descriptions to the journals where they more properly belong and where many of them have already appeared.

In general, and with but few exceptions, there was one very notable feature to an American about the exhibits, and one that is to a certain extent characteristic of the two nations. The Germans are very careful, thorough, indefatigable workers; their work shows thought, intelligence and a thorough knowledge of the underlying principles (though not necessarily knowledge of what has been done outside of their own country), but they appear to lack invention. They will work out with much trouble and care the best theoretical conditions (which sometimes lead them to impracticable constructions), but they lack the faculty of invention which suggests new practical conditions and simple ingenious contrivances. The Americans, on the other hand, possesses the faculty of invention to a great degree, but their inventions and ideas, although bright and ingenious, not infrequently show the want of a fundamental and thorough knowledge of the subject, or a want of study and care in carrying them out. The numerous rejected or absurd applications in our Patent Office will show this. These statements are, however, only quite general; there are of course many notable exceptions in both cases. In general, therefore, there was a noticeable absence of novelties among the exhibits at this exhibition, but, on the other hand, they showed careful, intelligent and very creditable work.

There was another noticeable feature which has its parallel to a certain extent in the watch industry. In America the electrical industry has developed to such a degree that dynamos and motors are made from the same templates, and probably often with interchangeable parts. They are kept in stock, and installations must be made to suit these standard sizes. I am told that in one of our largest factories, anything different from the regular standard sizes or designs is undertaken with great reluctance and little interest. In Germany, on the other hand, the dynamos, I am told, are, as a rule, to suit the installations, and are varied in design to suit the requirements. In numerous cases in which I wished to find out what their usual practice was, it turned out that there was no usual practice; that the exhibit was the first, or among the first, of its kind made. In a pattern shop of one of the largest companies, I noticed about six different patterns for very large dynamos of about the same output, which had been used for only a few castings, and some for only one. Yet they state that they make a profit, even though the dynamos are very much cheaper than in the United States, while they are often fully as good, if not better. While the one system is more flexible and undoubtedly leads to a more perfect development of the dynamo, the other, although it does, to a certain extent, retard development, is unquestionably the most practical method when the sales are large, and it will, no doubt, be employed there when the industry assumes the proportions it has assumed here.

There was still another feature which was noticed, and I mention it here, not with mere fault finding intentions, but with the hope that we may correct a fault which we must admit does exist, to a certain extent, at least. In America there is sometimes a tendency to sacrifice quality of work for quantity, which is a natural result of the objectionable practice of awarding a contract to the lowest bidder, and is therefore not necessarily a fault of the manufacturers. In Germany much pride is taken in making and keeping one's reputation for doing good work; so much so, that the name of a company and the quality of the work they have done has perhaps more weight in awarding a contract than the price. The natural result is that work is more creditably and carefully done; there is a greater variety in the systems used, and they are better adapted to suit the special requirements of the particular installations.

A noticeable feature to show the preference for substantial work is seen in one of the accumulators exhibited. Here in America the tendency has been to get the greatest possible output per pound of weight, or, in other words, to put in as little material as possible; the result is that the accumulator here is a frail, delicate object which must be accompanied by a nurse, or its life will not be guaranteed by its maker. In Germany they have discarded this policy to a great extent. The accumulator which is used there most frequently, and much more in proportion than accumulators are used here, is a strong, heavy, hardy Planté cell, with plates so thick that they are able to stand without being watched so carefully. The result of this is that many installations and central stations there are equipped with accumulators. I call attention to this particular case as there is no doubt that in the application of storage batteries to central stations they are far ahead of us, and we can learn much from them.

Regarding the nature of the recent progress in the electrical industry as exhibited, it may be said that excepting the rotary current systems there was no radically new departure shown in any of the prominent branches. The exhibits as a rule showed that the erratic progress made in the earlier years was being replaced by a steady, natural and healthy progress, such as may be expected in any important industry receiving the attention that this one is. Impracticable and absurd ideas are dying a natural death and the wholesome effects of the law of the survival of the fittest are plainly to be seen. Although the progress of the introduction of electric light and power in Germany has been much slower than in the United States, it has been and continues to be a steady progress. The Germans may think twice before they act, but when they do act they do their work well and thoroughly. New York was the first city to have a large local central station plant for incandescent lights in a small limited district, but Berlin will soon be ahead of New York, if it is not so already, in having an extended, homogeneous, well planned, underground system for supplying incandescent lights to a very large part of the city. The motive there is not to pay the greatest dividends, to speculate with franchises, or to supply politicians with boodle; their leading object is to supply the inhabitants with a reliable system of lighting, as cheap as is consistent with thoroughness. It is needless to say that in a well regulated government like that of Germany, the government controls the companies, and does not allow itself to be controlled by them. In street lighting and doubtless also in the distribution of power and the application of motors, they are far behind us, and can learn much from us, but in their manner of introducing complete systems of supplying lights in their cities we have much to learn from them.

Electric railroads on the continent were conspicuous by their almost total absence, yet the conduit system used in Budapest, in Hungary, which is probably the largest network of lines in Europe, is apparently one of the most satisfactory of any system in use anywhere, here or abroad, at least where the appearance of the streets has any weight

* A paper read before the American Institute of Electrical Engineers, at the Electric Club, New York, Nov. 24, 1891.

at all. One has only to compare a certain place in Buda-Pesth, where there are many crossings, curves and switches, with a similar place in Boston to appreciate the difference from an æsthetic standpoint. The trolley wire is no doubt the best system for suburban and interurban lines, or for small towns, but in a large city which takes any pride in its appearance the trolley wire should and will give way to less hideous systems.

Proceeding now to the individual exhibits, it is not the place here to attempt to describe them in detail. I will confine myself here to mere general remarks, leaving detailed descriptions to the journals where they more properly belong.

The historical exhibits were quite naturally limited to those of Germans. Great prominence was given to Soemmering as the original inventer of the telegraph in 1809. His statue was seen in several places, and his original apparatus was exhibited in operation. The original apparatus of Reiss, the inventor of the telephone, the electrical machine of Gœthe, and the original apparatus of Hertz were among the most interesting historical exhibits.

Among the many firms exhibiting the most prominent was, no doubt, the firm of Siemens & Halske, the largest electrical manufacturers in Germany. Their field is apparently unlimited, as they exhibited creditably in almost all the branches of the electrical industry. They appear to make a specialty of nearly every branch, and in some of them they unquestionably excelled. The firm of Schukert had the next largest exhibit; although not so broad in scope, it was in some respects possibly more creditable. "Helios," who represent the Austrian firm of Ganz & Co., came next in order of size of their exhibits, which was limited entirely to alternating current machines and systems.

The exhibits of these three firms, one at each end and one in the middle, occupied the greater half of the machinery hall. The Allegemeine Electricitäts Gesellschaft, of Berlin, and the Oerlikon company, of Zurich, came next in point of prominence. Their joint exhibit of the rotary current power transmission may be said to have excelled the others in point of interest, as it was undoubtedly the most interesting exhibit to the engineer as well as the most novel.

The exhibitions of dynamos were, as a rule, very creditable, both as to workmanship and, particularly, as to absence of sparking at the brushes. It cannot be said that any one firm predominated. There was in fact, probably, a greater variety of form than at any other exhibition; there were scarcely two alike. A very noticeable feature was that all large machines were multipolar; large bipolar machines apparently do not exist in Germany, and in this respect they are doubtless ahead of us. One reason for this is, no doubt, that their large dynamos are almost without exception coupled directly to the engine. This leads to slow speeds and consequently to armatures of large diameters, which of course excludes bipolar fields. In several prominent cases the armatures were outside of the radial multipolar fields, a practice which I believe is not attempted in this country at all. A happy medium between the two appeared in the large flat ring armature of Schukert, which combines the advantages of both. The largest dynamo was that of Siemens & Halske, having 10 radial poles, around the outside of which revolves a large Gramme ring armature, 10 feet in diameter, whose external surface is bare and acts as the commutator. There are 10 sets of brushes of three each, making 30 brushes to take care of. These dynamos have an output of 600 kilowatts at 100 revolutions, and are the units for their central stations, chiefly for those in Berlin. They state that about 30 of these have been installed. The large alternating current dynamos exhibited were made according to the old models, with radial magnets. A very serious objection to this form appears to be that the machines make a very loud humming noise, like that of a low toned steam whistle. So loud was this noise that it made conversation difficult, and in fact almost impossible in the neighborhood of the large machine, for which reason it was called the "growler" or "grumbler" by the rival exhibitors. Among the more unusual forms of dynamos may be noted the Fritsche continuous current and the Kingdon alternator, having no moving wire, both of which have been described in the electrical journals.

It appears that carbon brushes are limited chiefly to motors, and especially to railroad motors, where they appear to have replaced the others entirely. The form of brush almost exclusively used for dynamos is one made of fine copper wire gauze, an important feature being that the fibres run diagonally and not crosswise, thereby avoiding a fraying out at the ends, which was formerly a great objection to them. The chief advantages of this brush are that it is soft and does not "scream" like wire or foil brushes and that it is easily made. It is strange that it is not adopted in this country. Bearings are, as a rule, made with self-feeding arrangements, like a ring or a wick having an oil reservoir below the bearings. Speeds are almost invariably low and armatures large. Field magnets are generally very short and thick, a natural accompaniment of multipolar fields. Large dynamos are, as a rule, coupled directly to the engine. The workmanship on the dynamos was, as a rule, very good, as was also the construction, apart from the design; the design was, in a number of cases, awkward and cumbersome.

Among the various systems of distribution exhibited the simple 110-volt continuous current system still leads for isolated plants. Alternating current systems are not used for smaller plants, being chiefly limited to central stations. Arc lamps are as a rule run from the same mains as the incandescent, being connected two in series, together with a dead resistance. This resistance represents a dead loss of power, reaching as high as 20 and 25 per cent., but it is a necessary part of such a system, as the lamps often have shunt coils, which would be of no use as a source of regulation if there were no resistance in series with the lamp. Whatever disadvantages attend such arrangement, it must be said that the arc lamps burn far better there than here. Our restless, flickering lamps contrast very unfavorably with the average lamps seen at this, or at the late exhibition at Paris.

Although the amount of power represented by the alternating current system was quite great, the number of exhibits of this system was comparatively small as compared to the others, showing that the continuous current systems still predominate in Germany. The largest dynamos of the alternating type were those of the "Helios" company (Ganz & Co.) and of the Lauffen-Frankfort transmission. The "Helios" company uses 2,000 volts and about 83 alternations. Arc lamps and small motors were run indiscriminately from its mains. The next important system of distribution was the accumulator system, in connection with the three wire distribution, an arrangement which I believe is seldom used here, though it seems to be quite common there, judging from the exhibits. In this system one or more dynamos of about 250 volts charge two sets of accumulators in series, each of about 125 volts. These are connected to the three mains of the three wire system, the neutral wire being connected to the middle of the series. By means of switches connected to the outside cells, the voltage for the long and the short feeders may be made greater and less respectively, and the cells may be cut out when fully charged.

The only important system for arc lamps was an American exhibit, by the Thomson-Houston Co. Such systems may truly be called American, as they do not appear to be used to any extent by the German or French companies, who seem to acknowledge that we are their superiors in this branch. The result of the neglect to develop this system is, that in European cities arc lamps are rarely seen in the streets, at least when we compare their streets to those of American cities.

The series incandescent system, I believe, was not represented at all at this exhibition. It also may be called a truly American system. The five wire system was represented, but it failed to leave a favorable impression; and, as far as I could ascertain, it is in use in a central station in only one city, the home of the company advocating the system. This fact speaks for itself.

Among the systems of distribution of power may be mentioned, above all, the rotary field system of the Lauffen-Frankfort exhibit. It is truly a system of distribution as compared to a mere system of transmission. Next in interest were the alternating current motors, run from the "Helios" company's system. They were mere alternating current machines, with a rectified current in the field, obtained from a commutator. They appear to have a dead point, at which they will not start. They make some noise at starting, and there are more or less brilliant arcs at the commutator until they run synchronously, but after that they appear to run well. Motors from 1 to 5 h. p. will start in from 6 to 23 seconds.

Among the systems of simple transmission of power as distinguished from systems of distribution, the largest was a 2,000-volt continuous current system exhibited by Lahmeyer. The receiver in this system was an ingenious continuous current transformer of the motor dynamo type. The system of switches for starting, controlling and regulating the power and for protecting the apparatus as well as the attendants was very complete and very creditable to the designer, but the whole system failed to show any material advantages over the alternating current systems; on the contrary it left the impression that it was inferior. Besides these systems there were also a few motors run with a two phase rotary field current using four wires, by Schukert. These motors were started unloaded, and without a field current; the latter, obtained from a commutator, was switched on when the motor had reached synchronism.

The exhibits of electric railroads were meagre, and with one exception (the Budapest system) they were unsatisfactory to an American, as they were experimental systems, as distinguished from normal systems. In this branch they have much to learn from us.

Among the transformers there was apparently nothing of particular interest. The firm of "Helios" has abandoned the old form of Zipernowsky-Deri (or Faraday) transformers, and has adopted one like the usual forms, in which the disposition of the coils is a more practical one. Motor-dynamo transformers, or dynamotors, were quite frequently seen and appeared to be very much more frequently used than here.

[The remainder of the paper was a description of some of the more prominent exhibits, accompanied by slides showing a number of interior and exterior views of the grounds and buildings and detailed views of some of the exhibits, more particularly of the Lauffen-Frankfort transmission experiments, most of which have been published in the foreign and domestic journals and are therefore omitted here at the suggestion of the author.—Editor.]

Electrical Exhibits at the Columbian Exposition.*

BY PROF. J. P. BARRETT.

Electricity, as an adjunct to industrial procedure, has ceased to be empirical. Its practicability, economy and the conveniences of its employment are settled and incontrovertible facts. Its conduct under fixed conditions is no longer problematical. The laws which rule its action are as inviolable as those of the exact sciences, as constant as those of nature, of which they are a part.

In making plans, therefore, for an exposition of electrical development, the practical side of the question must be ever uppermost. The chief aim must be to demonstrate beyond cavil that as a factor in the affairs of this workaday age, electricity cannot but be taken into great account. This, the chief feature, however, would fail of its force were we to neglect to demonstrate at the same time the immense strides that have been made since electricity emerged from a state of mystery and became one of the essentials of civilization and progress.

Following out this preliminary reasoning, I think it necessary to treat practical electricity in classes according to the importance and relationship of its application.

The question of railway and other processes for transporting passengers and freight is the most vital economical issue of the present day. Steam, either by locomotive or cable, has been the only feasible motive power up to within a short time. The manifold objections to it, however, have increased the activity of inventors and the possibilities of rich reward have been a stimulus to the energy of electrical workers. Electricity in some branches of this service is already a success, and is fast displacing other motive power. The next few years, possibly the next few months, will probably see the whole question finally settled by some new element or the further development of one or other of the existing electrical systems. It will be part of our duty, therefore, to give every facility to exhibitors to make displays of new systems and to exploit old along new lines and under new circumstances. In order to do this it is contemplated to set aside a parcel of ground at some point of the exposition on which to build trial tracks, which may be equipped for the different systems. We should make it possible for every system to be demonstrated, so that not only the electrical people may judge of their respective merits, but that visiting capitalists and possible customers may have ready facilities for becoming interested in the subject itself or in any of the various inventions or systems on exposition. It is to be hoped that in this class of work the electrical people will submit something which should decide the question of transportation wholly in favor of electricity—as it already in part has done—whether it be by means of overhead, conduit or accumulator systems. I have only to say that the public at large, and those who are interested in the question from a financial standpoint, have high anticipations in this direction, and there is a disposition to wait for developments.

Electric lighting, arc and incandescent, has already arrived at a point of practical success. For illumination purposes electricity is accepted and stands without competition. The developments in this direction will be as thoroughly demonstrated at the Columbian Exposition as it is possible to conceive of. All the various systems of lighting and of the transmission of power will be placed in practical operation for service. Nearly if not quite 25,000 h. p. will be applied to electrical transmission at various parts of the grounds and buildings. It is contemplated to engage each company undertaking work, to wire and equip the locale of its distribution, furnish its own lamps, material and supplies, so that each company's system of construction and operation will stand entirely alone, to show its especial merit or to receive condemnation for failure. In this work it is contemplated to bring into friendly but brisk business competition the companies and systems of this country and Europe. The questions of the saving of energy by the perfection of machinery and insulation will be closely calculated, and the various systems will be thoroughly tested by the efficient juries on awards, of which more hereafter. Artistic lighting of theatres, hotels, residences and streets will be given an impetus, placed as these features will be in competition with art in every other conceivable dress. The brisk, practical business methods of the electrical people of this country have left little time to art and æstheticism up to the present time, while the people of Europe have on the contrary led art and electricity hand in hand. The Columbian Exposition may have some surprises in store for visitors in this behalf, and will undoubtedly be a source of much pleasure and instruction.

The transmission of power from sources at points along available watercourses or in the immediate vicinity of fuel for steam, and remote from the desired point of application, has been given much attention of late, and much newspaper comment has been made upon alleged successful inventions. This has seemed to me surprising, coming from electrical journals at least, since all of us in this country ought to be aware of the fact that long distance transmission has long been an accepted application of electricity in the mines of the West and Southwest, and has done much toward revolutionizing the processes of mining. At many points in the West far removed from fuel for steam, and at long distances from water power, mines are being successfully operated that could not have been so where fuel was to be delivered at the mine instead of the developed

* Paper read before the Chicago Electric Club, Jan. 4, 1892.

power ready for application. Some new things have come into practice in this field of electrical work in Europe of late and at the Columbian Exposition we will see an increased interest in this work of transmission, and there is in contemplation a project to make a most instructive object lesson by placing in practical operation a water wheel and motor the power of which will be applied at an artificial mine some distance away. The many applications of the electrical current of various quantities and qualities in mining and milling work will come under this head, and I am assured of some new and valuable contributions in the way of machinery.

In the whole field of electrical invention, moreover, there are promised models of invention setting out new principles, and numberless contrivances will be a part of the exhibit to testify to the large measure of usefulness of electricity in the various directions of its application. It is hoped also that the exhibits accepted will be object lessons to the general public which will inculcate a clear judgment to appreciate the fact that there are legitimate uses of electricity and that on the other hand there are applications of the current which closely border upon the fraudulent, and which are mere catchpennies and brought foward wholly because of the mystery and hocus pocus that surround them. I feel it a part of the duty of the department of electricity to unreservedly oppose the presence of these things and by discountenancing them have an effect in a degree to rob them of their harmful influence. People must come to understand that electricity is not a mysterious force, uncertain in its operation and liable to all sorts of eccentric deviation from the desired course. Until this understanding has been arrived at with the public, the electrical people will suffer more or less from frauds practiced by the unscrupulous, and will meet with obstructions in the shape of legal injunctions to prevent the laying of electric roads and lines of wire for transmission, and the actual dangers of electricity will be magnified many fold by those interested in restricting its use.

The remaining feature of the electrical exhibit, but not by any means the least for being mentioned last, is that part which will create object lessons on electrical progress —the historical exhibit. It would be impossible to fully appreciate the greatness of the progress made, and the magnitude of the work of making commercial electricity what it is to-day, without the presence at any exposition of the first crude machinery—the initial appliances by which the electrical current was made a useful force. It is contemplated to have some of the original models, and where this is found impossible, to have reproductions of the models of the apparatus of Morse, Franklin, Vail, Henry and many others of our own country, and those of Ohm, Ampère, Gauss, Siemens and many others of Europe. The department is in correspondence at the present time with those people or governments that have control of museums or institutions of learning where any of this historical apparatus may be, and we earnestly hope to have a full exhibit of these priceless treasures.

It is not contemplated by the National authorities of the Columbian Exposition to offer awards which would have so great an intrinsic value as to attract exhibitors, but it is contemplated to make the standard of excellence so high that the bare acceptance of an exhibit by a department will be a lasting and distinguished honor. In the Electrical Department, the space available for exposition purposes will be so small as compared with the demand, that the greatest judgment will have to be brought into play to decide what exhibits are worthy of a place and what will have to give way. It will be impossible to accept all. Therefore the presence of an exhibit in the Electrical Building will be a testimonial of its unusual merit. The awarding committees have determined to have full and exhaustive tests made of all machinery in competitive exhibition, by the juries of the different departments, and to publish these tests and the jury findings, at the close of the exposition, under the authority of the National Commission.

I regret that it is impossible at this time to present figures and definite information as to the prospects and scope of the department. It is yet 16 months before the opening of the exposition, and while an amount of space in the department building has already been applied for in excess of the total amount available, we have heard from fewer than one-half of the probable applicants for space. A delicate task is before the department, therefore, and it will be advisable to discuss the question in detail for some months to come, when I hope to have heard from all the electrical people. I will then be in position to discuss the matter more fully and more in detail in a paper which I shall ask to present.

New Vertical Non-Condensing Engine.

The tendency of engine building for electrical purposes is strongly in favor of the vertical, owing to the economy of space and operation afforded by this type. One of the most notable efforts in this direction is now being made by the Philadelphia Engineering Works. They have recently perfected a 500-h. p. upright condensing engine with a Corliss liberating valve gear. A drawing of this is given herewith. This engine is intended to receive steam at 150 pounds gauge pressure, and is designed to run at 110 revolutions per minute, giving a piston speed of 550 feet per minute. The high pressure cylinder is 22 inches in diameter and 30-inch stroke. Low pressure cylinder, 31 inches in diameter, with the same stroke, the ratio of the two cylinders, therefore being 1 to 2.

In the development of 500 h. p. this engine will expand its steam down as near the atmospheric pressure as would be economical. Therefore, to obtain a less power than 500 horse, it would be advisable to operate the engine at a lower boiler pressure. With steam at 150 pounds gauge pressure it will develop from 1 to 600 h. p. with good economy.

The engine occupies but little space for the power developed, the bed plates of each engine being 3 feet 9 inches wide and 7 feet 5 inches in length. The total width of the bed plate of the two engines measured over all is 10 feet. The platform shown in the illustration is 15 feet over all in width, but where room is a great consideration this may be reduced. Total height of the engine from the bottom of the bed plate to the top of the cylinder bolts, 15 feet 7 inches.

The main shaft, as shown, is 10 inches in diameter, with two solid forged cranks. The crank pins are also 10 inches in diameter, each of the bearings being 13 inches long and 10 inches in diameter, furnishing 26 inches of bearing for each engine. The bed plate is 18 inches deep to the bottom of the frame, and the shaft is situated so that the bottom of it does not reduce the strength of the bed frame; that is, it does not cut into the bed frame so as to reduce its depth at this most important point.

There are two frames, each being a solid frame with a deep rib in the sides, giving excellent stiffness and strength to the machines.

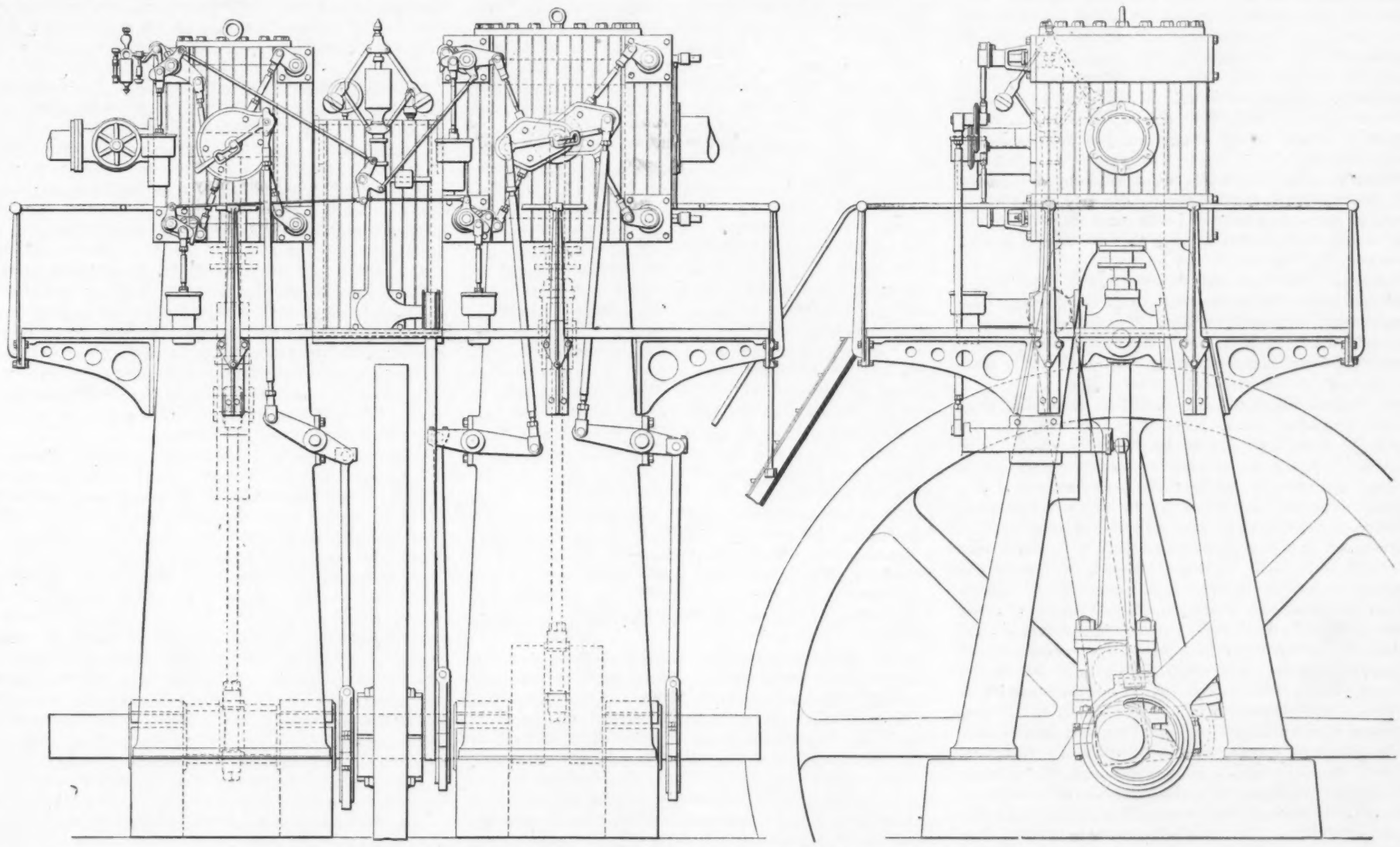
The slides are bored out to 5½ inches radius, each slipper being 16 inches long and 7 inches wide. They are babbitted with genuine babbitt metal, and fitted to the steel crosshead upon a taper. They are arranged to be adjusted with the greatest delicacy with a screw bolt, and secured so as to give ample rigidity.

The fly-wheel is 14 feet in diameter, and weighs 20,000 pounds. As it is intended to be supplemented by larger pulley wheels, or to drive the generator direct, this is expected to be quite ample, but where the fly-wheel is not so supplemented it will be desirable to increase its weight at least, if not its diameter.

The area of the steam port of the high pressure cylinder is 26 inches, the exhaust ports 38 inches, and in the low pressure cylinder the inlets have 48 square inches, and the exhaust an area of 67 square inches.

The piston rods are 3⅞ inches in diameter. The shaft, as before mentioned, is 10 inches in diameter and is expected to have about half its power usually taken from either end. Connection between the two cylinders is effected by a receiving receiver of large capacity and good heating power. In this is introduced three diaphgrams, so that the steam must traverse up and down it twice before entering the low pressure cylinder. The area of the passage is amply large and but slight friction resistance is to be met with. Upon this receiver is bolted the governor to control the liberating gear. The governor is well situated for making short connections to the different induction valves, and is at the same time placed in a recess so as to be out of the way of the engineer, and yet it is well in view to add to the good appearance of the machine as a whole. The governor is arranged to operate very sensitively upon the high pressure cylinder, but very slowly or sluggishly upon the low pressure cylinder. The connections are first set to give the greatest amount of follow to both cylinders. As the balls rise they rapidly reduce the amount of steam admitted to the high pressure cylinder while slowly reducing the amount of follow in the low pressure cylinder. In this way a better regulation is secured than hand control of the low pressure cylinder, and extreme variations in the receivers are avoided.

But one eccentric is used for the high pressure cylinder, as by it steam may be allowed to follow half stroke, and sufficient compression is obtained when expanding into a second cylinder. The low pressure cylinder, however, has



DETAILS OF THE NEW VERTICAL ENGINE OF THE PHILADELPHIA ENGINEERING WORKS.

two independent eccentrics which are set to effect the longest practicable follow with an excellent compression. Early closing in the non-condensing exhaust is not so essential as in the condensing engine, yet the best economy is only effected when it is resorted to. The cylinders, however, have the minimum clearance possible in short stroke engines. It is well known that the Corliss gear is good in this particular, and the makers have refined this point to the best of their ability, cutting it as low as possible without interfering with the freedom of the passages or the rapid action of the gear. In this gear the proportion of the parts and the lazy action of the plate are so arranged that a full port on the steam side is obtained before one-seventh of the piston's travel is accomplished.

The engine is handsomely finished throughout. The lagging of the cylinders and intermediate-receiver is of black walnut secured with brass screws and bands. The gear is thoroughly well finished and the engine well painted with hard varnish paint to give it a first-class finish. It is supplied with thorough lubricators in every bearing of importance, and has sight lubricators where the bearing is stationary. The cross head and crank pins are supplied with wiper oilers, and the slides with sight feed oilers. The cylinder is supplied with necessary valves and attachment for indicators. The receiver has a pop safety valve and steam gauge.

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1791.——Shaw (George), English naturalist, who became a Fellow of the Royal Society during the year 1789, communicates to the latter body a paper on the *Scolopendra electrica* and *Scolopendra subterranea* ("Linn Soc. Trans.," I., pp. 103–111). This was afterward translated into Italian and appeared in vol. IX., page 26, of Brugnatelli's *Annali di Chimica*. Mr. James Wilson, F. R. S. E., in his "Encycl. Brit." article on *Myriapoda*, alludes to the *Scolopendra electrica* as figured by Frisch and described by Geoffroy in his "Histoire des Insectes," vol. II., page 676, n. 5. Shaw also treats of the *Trichiurus Indicus*, which Sir David Brewster believes to be the same as the *trichiurus electricus*, known to inhabit the Indian Seas and to have the power of giving electric shocks.

Five years before the above date (1786), the *Phil. Trans.* contained (page 382) the description of the *tetraodon electricus*, which Lieutenant William Paterson discovered in the cavities of the coral rocks of one of the Canary Islands and found to possess the properties of other electrical fishes.

See "Biographie Générale, vol. XLIII., page 922; *Gentleman's Magazine*, vol. LXXXIII.; Poggendorff, vol. II., page 918; "Cat. Royal Society Sc. Papers," vol. V., page 674; Dr. Thomas Young, "Course of Lectures," London, 1807, vol. II., page 436, for the *Trichiurus Indicus*. . .

Having thus far called attention to the most important varieties of the electrical fishes, notably at the articles, Adanson (A. D. 1751), Bancroft (A. D. 1769), Walsh and Hunter (A. D. 1773), the following original list of additional references will prove interesting:

Raia Torpedo.—S. Lorenzini, "Osservationi . . .," Firenze, 1678; R. A. F. de Réaumur, "Des Effets . . .," Paris, 1714; Templeman, in "Nouvelliste," 1759; Ingenhousz (*Phil. Trans.*, 1775); Cavendish (*Phil. Trans.*, 1776); F. Soave (Scelta di Opuscoli," vol. XV.), Milano, 1776; J. A. Garn, "De Torpedine . . .," Witteb., 1778; R. M. de Termeyer (Raccolta Ferr. di Op. Sc. . ., vol. VIII.), Venice, 1781; L. Spallanzani ("Goth. Mag.," v. I., 41; "Opusc. Scelti," VI., 73), Milano, 1783; Girardi and Walter ("Mem. Soc. Ital.," iii., 553), Verona, 1786; W. Bryant ("Tr. Amer. Phil. Soc.," ii., 166, O. S.), Philad., 1786; J. W. Linck, "De Raja Torpedine," Lips., 1788; Vassalli-Eandi (*Journal de Physique*, vol. XLIX., p. 69); Geoffroy Saint-Hilaire ("Annal. du Mus.," An. XI., vol. I., No. 5, and *Phil. Mag.*, vol. XV., p. 126), 1803; J. F. M. Olfers, "Die Gattung Torpedo . . .," Berlin, 1831; Linari-Santi in "Bibl. Univ.," Ser. II., Geneva, 1837–1838, and in "Bibl. Ital.," vol. XCII., p. 258, Milan, 1839; C. Matteucci, "Recherches . . .," Genève, 1837, also Della Chiaje, "On the Organs . . .," and P. Savi, "Etudes . . .," Paris, 1844; G. Pianciani ("Mem. Soc. Ital.," XXII., 7); F. Zantedeschi ("Bull. Acad. Brux.," viii., 1841); A. Fusinieri ("Am. del Reg. Lomb.-Veneto," VIII., 239), Padova, 1838; A. F. J. C. Mayer, "Spicilegium . . .," Bonnæ, 1843; L. Calamai, "Osservazioni . . .," 1845; C. Robin, "Recherches . . .," Paris, 1847; Krûnitz, "Abhandl.," XVII.; *Nicholson's Journal*, vol. I., p. 355; Rozier, IV., 205; "Acad. Brux.," 111.

Silurus Electricus.—Ranzi, on the discovery of the discharge of this animal; P. Forskal "Beobachtungen . . .," 1775; F. Pacini, "Sopra l'Organo . . ." Bologna, 1846.

Gymnotus Electricus.—T. Richer, "Observations . . ," Paris, 1679 ("Hist. et Mém. de l'Acad. Roy. des Sciences," vols. I., p. 116, VII., 1 pt., 2, p. 92); A. Van Berkel, "Reise nach Rio . . .," Memming, 1789, for the observations made in 1680–1689; J. B. Duhamel ("Hist. Acad. Sc.," 168); J. N. Allamand, "On the Surinam Eel . . . , by S'Gravesande," Haarlem, 1757; Gronov-Gronovius ("Acta Helvetica . . ," IV., 26, Basle, 1760; *Phil. Trans.*, vol. LXV., part I, p. 94, 102, and part II, p. 395); P. V. Musschenbroeck ("Hist. et Mém. de l'Acad. des Sc.," 1760); G. W. Schilling, "Diatribe de Morbo . . . ," 1770, treating of the torpedo, as well as of the *magnetism* of the Gymnotus, which latter was observed by him in 1764, and is alluded to besides by Jan Ingen-housz in his "Nouv. Exper.," Paris, 1785; "Mem. of Berlin Acad. of Sc.," Bonnefoy, "De l'app. de l'élect . . . ," 1782–3, p. 48; Ferdinando Elice, "Saggio sul Elettricità," p. 26; Williams, Garden, Hunter, in the *Phil. Trans.* for 1775, p. 94, 105, 395; R. M. de Termeyer ("Opus. Scelti," IV., 324, for 1781); H. C. Flagg ("Trans. Amer. Phil. Soc.," O. S., vol. II., p. 170); Samuel Fahlberg, "Beskrifning ofver elektriska alen Gymnotus electricus," Stockholm, 1801; (See Fahlberg at A. D. 1769, and in "Vet. Acad. Nyr. Handl.;" Gilbert, *Annalen*, XIV., 416); Humboldt, "Observations . . . anguille elect . . . ," Paris, 1806, "Versuche . . . elec. fische," Jena, 1806, and in the *Annales de Chimie et de Physique*, vol. XI. for 1819; F. S. Guisan, "De Gymnoto . . . ," Tubingen, 1819, Carl Palmstedt ("Skand. Natuf. motets Forhand, 1842). H. Letheby ("Proceedings London El. Soc.," Aug. 16, 1842, and June 17, 1843); M. Vanderlot's work, alluded to by Humboldt at p. 88 of his "Voyage . . . "; F. Steindachner, "Die Gynotidie . . . ," Wien, 1868.

Consult, likewise, for electrical fishes generally, Rozier, Intr., II., 432; Bloch, "Naturgeschichte. . . ," Berlin, 1786; R. J. Haûy, "Traité de Physiqûe," page 41; Geoffroy Saint-Hilare (*Journal de Physique*, LVI., 242; *Phil. Mag.* XV., 261; "B. Soc. Phil." N. 70; Gilbert, *Annalen*, XIV., 397; "Ann. du Mus." for 1803); M. Schultze, "Zur Kentniss . . . elect . . . fische," Halle, 1858 and 1859; Jobert (de Lamballe) "Des Appareils . . ." Paris, 1851; W. Keferstein and D. Kupffer (Henle u. Pfeuffer's "Zeitschr. f. rat. Med. Newe Folge," iii., 1858) and Keferstein's "Beitrag . . . elekt. fische," Göttingen, 1859; "Annual of Sc. Discovery" for 1863, giving, at pages 115–116, the views of Sir John Herschel, of Charle Robin and of M. Moreau on the electrical organs of fishes.

A. D. 1792.——Berlinghieri (Francesco Vacca, and not Vacca Leopold nor Andrea Vacca), Italian surgeon and anatomical writer, communicates to Mr. De La Méthérie the result of the extensive experiments made by him in concert with Mr. Pignotti and his brother. After describing his investigations with frogs, he remarks that the same movements and contractions can be produced on animals with hot blood. The latter, he remarks, require, however, a peculiar process. After having dissected the crural nerve, or any other considerable nerve whatever, and cut it at a certain height to separate it from its superior part, it should have a piece of tinfoil wrapped around its summit, and the communication should be made in the usual way by touching the coating with one of the extremities of the exciting arc and the muscles in which the nerve is distributed with the other extremity.

Many other investigations of Berlinghieri were, later on, communicated to the Société Philomathique, by whom they were successfully renewed, and, during the year 1810, a translation of his paper on the method of imparting magnetism to a bar of iron without a magnet, appeared at p. 157, vol. XXXV., of the *Philosophical Magazine*.

See Rozier, XL., 133, and XLI., 314; "Giorn. di Med. Prac. di Brera," IX., pp. 171–298; L. B. Phillips, "Dict. of Biog. Ref., 1871," p. 137.

A. D. 1792.——Lalande (Joseph Jérome le François de), a distinguished scientist, and, doubtless, the best known of all French astronomers, who had previously communicated (1761) observations on the loadstone to the "Mémoires de Paris," and had likewise written upon meteoric displays (1771), addresses to the *Journal des Savans* of Nov., 1792, a treatise entitled "Une Notice sur la découverte du Galvanisme," justifying his claim to being the first introducer of galvanism into France, which he had before made through the columns of the *Journal de Paris* of the 17 Pluviose, An VII.

See Lalande, "Abrégé de l'Astr.," p. 101, etc.; "Biog. Générale," vol. XXVIII., p. 948 "Biog. Universelle," vol. XXII., pp. 603–613; Ninth "Enc. Britannica," vol. XIV., p. 225; P. Sue ainé, "Hist du Galv.," Paris, An X. (1802), vol. I. p. 1.

A. D. 1792.——Chappe (Claude), a French mechanician, (1763–1805) introduces the *sémaphore*, which he at first called a *tachygraphe*, from two Greek words meaning to write fast, but to which Mr. Miot, chief of one of the divisions of the War Department, gave the name of telegraph during the year 1793. Chappe had not long before devised a contrivance somewhat like that alluded to by Barthélémy (A. D. 1788), but it was not apparently brought into use.

His *sémaphore* consisted of a vertical wooden pillar 15 feet or 16 feet high, bearing a transverse beam 11 feet or 12 feet long, which turned upon its centre and held at each extremity pivoted arms which were so worked, by means of cords or levers, as to admit of 256 distinct signals. The semaphores were placed upon high towers, about four miles apart, on level ground, and even as much as 10 miles apart upon intervening elevations. This ingenious system of signals was presented by Chappe to the Assemblée Législative, and was originally erected during the month of August, 1794, upon stations between Paris and Lille (Lisle), a distance of about 148 miles. One of the first sentences conveyed between the two places by the Committee of Public Safety consumed 13 minutes and 40 seconds, but it was not long before despatches could be conveyed in two minutes' time, and it was through Chappe's apparatus that the news of the recapture of the city of Condé was conveyed to the Assembly shortly after the entry of the troops of the Republic.

So much importance attached to Chappe's apparatus that two models were made from a description of it taken by an emigrant from Paris to Frankfort-on-the-Main, and were sent by Mr. W. Playfair to England, where it was at once put into use in a modified form.

It is not now believed that Claude Chappe was acquainted with the devices of either Robert Hooke (A. D. 1684) or of Guillaume Amontons (A. D. 1704), as was at the time claimed by many of his jealous contemporaries, who besides endeavoring to deprive him of the honor of the invention, invidiously brought forward the many errors and complications likely to result from its general use. No doubt, however, exists that he is justly entitled to the credit of having, with the assistance with other members of his family, developed an entirely new system of signals as well as the mechanism by which they are operated. The histories of telegraphy written by I. U. J. Chappe (Paris, 1824; Le Mans, 1840) review Claude Chappe's investigations and the difficulties he encountered, besides making reference to the false magnetic telegraphs of A. T. Paracelsus (A. D. 1490-1541), William Maxwell (A. D. 1679) and F. Santanelli ("Philosophiæ reconditæ . . .," Coloniæ, 1723) alluded to in the "Dictionaire des Sciences Médicales."

Claude Chappe's uncle, L'Abbé Jean Chappe-d'Auteroche (1722-1769), French astronomer, who succeeded N. L. de la Caille at the Paris observatory as assistant to Cassini de Thury and edited a translation of the works of Dr. Halley, is the author of several memoirs upon the declination and inclination and upon lightning, meteors, etc., alluded to in J. B. J. Delambres "Hist. de l'Astron. au 18e siècle," in J. C. Poggendorf's "Biog.-Liter. Hand.," vol. I., p. 420, and in the "Mém. de Paris," 1767, *Mém.* p. 344.

See English Encyl. "Arts and Sciences," vol. VIII., p. 65; "Johnson's Encyl.," vol. IV., p. 757; "Penny Ency.," vol. XXIV., p. 146; Shaffner, "Manual," pp. 27, 45 and 48; *Sc. American Supplement*, No. 475, p. 7,579; "Emporium of Arts and Sciences," vol. I., p. 292; Rozier, XXXIV., 370, and XL., 329; "Bull. des Sc. de la Société Philomathique," March, 1793, No. 21, for an account of the experiments of Galvani and of Valli repeated for the Society by C. Chappe, Mr. Robillard and A. F. de Silvestre.

A. D. 1792.——Valli (Eusebius), Italian physician of Pisa, corresponding member of the Royal Academy of Sciences at Turin, publishes his "Experiments on Animal Electricity," the results of which were communicated to the French Academy of Sciences and found to be of such great importance that a committee composed of Messrs. Le Roy, Vicq d'Azyr, Coulomb and Fourcroy, was directed to repeat them. The most important were thus performed in Fourcroy's laboratory on the 12th of July, 1792.

Valli was the first to demonstrate that when an arc of two metals, plumber's lead and silver, is employed upon an animal, the most violent contractions are produced while the lead is applied to the nerves and the silver to the muscles. He also showed that of all metals, zinc, when applied to the nerves, has the most remarkable power of exciting contractions; and he found that when a frog had lost its sensibility to the passage of a current, it regained it by repose.

His experiments were also repeated by the French Royal Society of Medicine. Mr. Mauduyt, who was present, deduced from the results obtained by Valli that the metals were charged with a different quantity of the electric fluid, in so much that when they were brought in contact with each other a discharge ensued. And, secondly, that the animal body, by which the electric fluid is rendered perceptible, is a more delicate electrometer than any one heretofore discovered.

Many new and very interesting investigations were afterward made by Valli upon different animals, the results of which were given to the public through the columns of the *Journal de Physique* as shown below. These embrace thirteen experiments upon animals rendered insensible to the torture by means of opium and powdered tobacco, showing electricity to be independent of their vitality, as well as others to show that the electric fluid is necessary to man and animals. He also established the identity of the nervous and the electric fluids, and proves that by merely bringing the muscles themselves into contact with the nerves, without the intervention of any metal whatever, the convulsions took place. In answer to the inquiry of Mr. Vicq d'Azyr, member of the late French Academy of Sciences, he supported by nineteen experiments the assertion that however the blood vessels may be, as they assuredly are, conductors of electricity, the nerves alone are, in consequence of the mode in which they are disposed, capable of exciting muscular movements.

See Brugnatelli, *Annali di Chimica*, vol. VII., pages 40, 213, 228 (and pages 138, 159, 186, 208 for Caldani), also the "Giornale Fis. Med.," vol. I., page 264; P. Sue, Ainé, "Histoire du Galvanisme," Paris, An. X–1802, vol. I., page 45; "Société Philomathique," vol. I., pages 27, 31, 43; *Journal de Physique*, vol. XLI., pages 66, 72, 185, 189, 197, 200, 435; vol. XLII., pages 74, 238, the last named containing the "Lettre sur l' Électricité Animale" ("De animalis electricæ theoriæ . . . ," Mutinæ, 1792) sent by Valli to Messrs. De La Métherie and Desgenettes; Report of

*Continued from The Electrical World of Jan. 2, 1892.

Messrs. Chappe, Robillard and Sylvestre on Valli's and Galvani's experiments ("Soc. Phil." for March, 1793, No. 21); Report of Messrs. Le Roy, Vicq d'Azyr and Coulomb in "Médecine éclairée par les Sciences Physiques," tome IV., page 66; "Epitome of Electricity and Magnetism," Philad., 1809, page 133; "Versuche . . . animal. electricität" of Karl Friedrich Kielmayer (Kielmaier) of the Tubingen University (Poggendorff, vol. I., page 1,253; F. A. C. Gren, *Journal der Physik*, vol. VIII., for 1794), Floriano Caldani's works, 1792–1795, and those of Leopoldo Marc-Antonio Caldani, 1757–1823; Junoblowiskiana Society, 1793–1795.

Secondary Batteries.—I.*

BY G. H. ROBERTSON.

INTRODUCTION.

The secondary—or, as it should rather be called, the reversible—battery dates practically from the discovery that electric currents could be produced by the agency of chemical actions, and its development progressed with the increase of our knowledge of the laws which govern electrolysis.

In the year 1800, Volta discovered that a current could be obtained through chemical agency; and in the following year Gautherot observed that when electrodes of silver or platinum wire were used for the electrolysis of acidulated water, they gave a current in the reverse direction to that in which the battery current had been passing, if they were connected through a galvanometer directly the battery was removed.

These inverse, or polarization currents as they were called, were a source of great perplexity, and although much work was done on the subject, and many theories were started to account for their origin by Volta, Ritter, Marianini, Becquerel, Grotthus, and others, no satisfactory explanation was forthcoming until Faraday set the whole theory of electrolysis on a firm basis in his papers communicated to the Royal Society between June, 1833, and March, 1834.

Although many apparent contradictions have been found to Faraday's well known simple laws, and the precise mode in which a current is conveyed through an electrolyte is still under discussion, yet his work showed that chemical and electrical energy were mutually convertible, and that the so-called polarization currents were due to the reversible nature of the chemical changes caused by the passage of the primary current.

The way was thus cleared for improvements in batteries in general, and very many have been brought out; but it was not till much later, when Faraday's other great discovery of the laws relating to the conversion of mechanical into electrical energy bore fruit, and provided a cheap source of electricity, that much attention was paid to reversible batteries.

In the course of his experiments on electrolysis he nearly anticipated Planté's discovery of the peroxide of lead-lead couple, for in the case of the electrolysis of a solution of acetate of lead he noticed that on the passage of the current peroxide of lead was formed on the one plate and lead on the other.

In 1843 Grove invented his gas battery, and in 1852 Dr. C. W. Siemens constructed a reversible battery, using carbon plates as his electrodes and a strong solution of acetate of lead as his electrolyte.

In 1859 Planté made a number of experiments with copper, silver, tin, lead, aluminium, iron, zinc, gold and platinum voltameters, to determine which was the best couple to use for a reversible battery, and decided on the use of lead plates in dilute sulphuric acid, because in discharge both plates were active—that is, not only did the peroxide of lead plate combine with hydrogen, but the reduced metallic lead combined with oxygen; thus the E. M. F. of the cell was due to chemical actions occurring on both plates. In those days the action of the cell was ascribed solely to the decomposition of water, and the effect of the sulphuric acid was left out of account.

In 1872 Planté improved the "formation" of his cell by bringing out the process for alternate reversals of the current, and in the decade which followed, with the improvement of the dynamo, and the consequent growth of electrical engineering, the need for some means of storing electrical energy arose, and the reversible battery passed from the laboratory into commercial use.

REVERSIBLE BATTERIES.

In 1880 M. Camille Faure invented his cell, in which the electrodes consisted of lead plates, smeared with pastes of red lead and litharge, respectively, and covered with a protecting layer of felt. On charging, the red lead was oxidized to peroxide of lead, and the litharge was reduced to metallic lead, thus quickly forming a Planté couple of considerable storage capacity.

The same impetus in electrical work which gave rise to the Faure battery led also to the introduction of several other types of reversible batteries, and as I have been able to obtain very little information about them I will deal with them and their developments now, before proceeding with the numerous improvements in the two lead types.

Profs. Thomson and Houston have tried electrodes of copper in sulphate of zinc solution; the plates were laid horizontally, so that the relative weights of the sulphate of zinc and sulphate of copper formed in the working might prevent their mixing too readily. The E. M. F. was the same as that of the Daniell.

M. d'Arsonval modified this battery by making one electrode of lead and the other of zinc, the solution being sulphate of zinc, as before. The lead plate forms the positive, and becomes coated with peroxide during charge. According to Miesler, the E. M. F. of this arrangement is 2.13 volts.

Sutton tried copper and lead plates in copper sulphate, the E. M. F. being 1.22 volts.

In 1886 M. Dezmazures brought out a modification of the Lalande and Chaperon cell, the solid copper plate being replaced by a porous one, made by first reducing copper oxide electrically, and then compressing the fine metallic dust so obtained into plates.* The other electrode was made of tinned iron gauze, and the solution was potassium zincate. The E. M. F. is only about one volt, but the cells are light, and a battery of this description gave satisfaction as a source of motive power, at the trials on the French torpedo boat "La Gymnote," at Toulon. Recently this battery has been tried for traction work in Philadelphia, under the name of the Waddell-Entz accumulator.† In the American form of the battery the copper plates are made of a sort of wire rope, formed of a stout wire core, braided over in opposite directions with two layers of wire of different thicknesses, the finest outside. This is again braided with asbestos, or some similar material, which retains and protects the copper oxide formed by electrolysis. The weight of the battery is given as from 55 pounds to 60 pounds per h. p. stored.

LEAD REVERSIBLE BATTERIES.

On the introduction of the Faure cell into England, in 1881, great hopes were entertained of it, and the modification in the manufacture of the plates seems almost to have been regarded as constituting a fresh type of cell; whereas, since the couple was identical, the chemical reactions were the same as in the Planté cell, and any defect due to these would be common to both. As lead reversible batteries cannot be said to have completely realized the hopes then entertained, it is important to discover whether the non-fulfillment is due to causes which can be remedied by improved processes of manufacture, or whether they arise from the chemical reactions occurring in the working

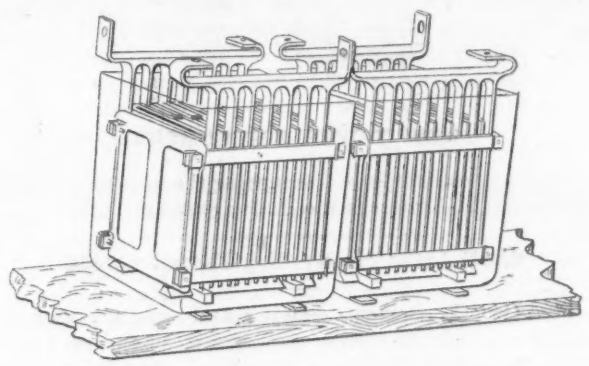


FIG. 1.—MESSRS. DRAKE AND GORHAM'S CELL.

of the cell, and are to be met rather by improved treatment after than during construction. I have thought, therefore, that a paper containing a summary of some of the principal improvements which have been introduced in the construction of cells, and an account of some experiments dealing with the chemistry of the subject, might lead to some useful discussion.

From a comparison of the two cells made by M. Achard it appears that on its introduction the internal resistance of the Faure was much higher than that of the former, while the Planté cell took longer to form and was heavier than the Faure. The time required for formation and the weight of the cell were the chief drawbacks to the Planté process of manufacture; the Faure method had the disadvantage that the applied paste was liable to separate from its support. The remedying of these defects, then, has been the principal aim of the improvements which have been brought out in the two types of the lead reversible battery.‡ To give a complete list of these would be quite beyond the scope of this paper, but they may be summarized as follows:

I.—Improvements in the Planté type, *i. e.*, that in which the peroxide of lead and spongy lead are formed direct from metallic lead by electrolysis.

In this type, since both the weight of the plate and the time required for "formation" can be shortened by making the plate porous, and thus exposing more surface to the action of the acid and charging current, obtaining porosity has been the chief aim of inventors. The methods which have been suggested from time to time may be classified under three headings:

A. Chemical.—The plates are subjected to some "pickling" process, or some special "forming" bath is used.

B. Mechanical.—The plates are made of granulated lead wire, or some form of finely divided lead.

C. Electrolytic.—(1) The finely divided lead is obtained by the electrolysis of some salt of lead. (2) Some salt of lead is formed into a plate by pressure, or otherwise, and then reduced to metallic lead.

I.—IMPROVEMENTS IN THE PLANTÉ TYPE.

Chemical Processes.—Planté found that plates of lead which had been steeped for a long time in dilute sulphuric acid before being submitted to the action of the charging current "formed" more rapidly than those which had not been so treated, and he also found that "formation" was hastened by heating the cell during the process; this, however, was difficult in practice.

In 1872, in order to roughen the surface, he pickled the plates for from 24 to 28 hours in a bath composed of nitric acid, diluted with from once to twice its volume of water. The plates were then thoroughly washed, and the formation completed in a bath of dilute sulphuric acid 1 to 10. By this improvement he stated that a capacity, which under the old process took several months to obtain, could be acquired in eight days.

Almost simultaneously Messrs. Elwell and Parker suggested the use of a mixture of nitric and sulphuric acids as a pickling bath. Since then different baths containing nitric acid in varying proportions have been brought out, and from the earliest times the addition of some salt of the alkalies, such as ammonium, sodium, potassium, or magnesium sulphate, to the electrolyte during formation has been suggested as an improvement.

In 1884 Mr. FitzGerald proposed the use of phosphoric acid, and in the same year Mr. Tribe experimented with plates partially or wholly converted into sulphide, phosphide or arsenide, prior to "forming" them by electrolysis.

Coming to the recent processes, in 1890 Mr. Epstein suggested first boiling the electrodes in a bath containing one per cent. nitric acid, one per cent. potassium permanganate; or else, in lieu of the permanganate, two per cent. carbonate or sulphate of sodium, or one per cent. sulphate of manganese. The plates are dried in air, and then "formed" by the action of the current in an electrolyte containing acetic, phosphoric or tartaric acid in the proportion of half to two per cent.

A few months later Dr. Paul Schoop brought out his process for first subjecting the plates to the action of a current of about one-sixth of an ampère per 100 square centimetres at 50 degrees Fahr., in a bath composed either of 100 parts by weight ammonium sulphate, 140 parts by weight sulphuric acid (50 degrees), two-thirds one part by weight potassium chlorate; or else, 100 parts by weight water, five parts by weight sodium bisulphate, two-thirds one part by weight potassium chlorate. The treatment is continued for from 36 to 100 hours, according to the depth of the active material required. The formation is completed in ordinary dilute sulphuric acid.

MECHANICAL PROCESSES.

Messrs. Crompton and Howell's well known plates, formed by the compression of a specially porous granulated lead, are an instance of this type, and from their great porosity they are capable of a very high rate of discharge.

In Messrs. Drake and Gorham's cell (Fig. 1) both plates are formed of roughened strips of lead, laid horizontally one over the other, and connected by their ends to upright rods. From its construction this plate is free to expand and contract without injury to itself.

In Mr. Niblett's so-called "solid cell" the electrodes are separated by porous partitions, and the space between the electrodes and the partitions is filled up with granulated lead. In this cell there is practically no free electrolyte to wash about and spill; it is all absorbed either in the mass of spongy material forming the electrodes or in the porous partitions.

Plates have also been made of compressed lead dust, of wire loosely woven and compressed, as in Reynier's cell; or in the form of rope, as in the Legay cell.

M. Bandsept's plates would appear to be of this type, as they are made of extremely finely pulverized material, which is then compressed into briquettes, and subjected to a forming process. The cell is now in use commercially in Brussels, but very little information can be obtained about it.

ELECTROLYTIC PROCESSES.

1. *The Electrolysis of Some Lead Salt Solution.*—The acetate of lead has been frequently employed for this purpose since Siemens used it; and another salt that has been the subject of many patents is the chloride of lead. In America last year it was proposed by an Englishman, named Currie, to form the electrodes of rods or bars of lead coated with woven asbestos. These electrodes are then placed as anodes in a bath of zinc chloride, and lead chloride to the required depth is formed on them, while zinc is deposited on the cathodes. On reversing the current, spongy metallic lead is produced on what are now the cathodes, and the zinc goes into solution, being thus used over and over again.

2. *The Reduction of a Plate Formed of Some Salt of Lead.*—Perhaps more patents have been taken out under this heading than any other. Plates have been formed of the fused chloride; cerussite, or the native carbonate, has been compressed into plates, and, in fact, any salt of lead, even lead sulphate, which can be got to reduce to metallic lead by the action of the current, has been employed.

In the Laurent-Cély cell the plates are composed of pastilles of specially prepared lead chloride, round which frames of an alloy of lead and antimony are cast. By the action of zinc in very dilute hydrochloric acid, the plates

* Paper read before the Society of Arts, London.

* *The Electrician*, vol. XXII., p. 302.
† *The Electrical Engineer* (London), vol. VII., p. 556.
‡ For an account of the lead batteries on their first introduction into commercial work, and of the early suggestions to replace them, see a paper by Prof. W. Grylls Adams, F. R. S., read before the Science Society of King's College, Oct. 25, 1881, and published in *The Chemical News*, vol. XLV., p. 1. In Mr. Niblett's paper on "Some Recent Improvements in Lead Secondary Batteries," read before the Physical Society of Glasgow University last January, and published in *The Electrical Engineer* (London), vol. VII., Nos. 13 to 17, will be found an account of the principal structural improvements which have since been effected.

are converted into cellular lead. The plates are then washed in cold water, dried, and the positives converted into litharge by the action of a current of hot air. The formation is then completed by electrolysis in the usual way.

For this cell it is claimed that the density of the positives is 4.3 to 5, while that of the negatives is only 3 to 3.5. Great storage capacity for weight is also claimed.

(To be continued.)

A Permanent Magnetic Field.

At the meeting of the Physical Society, of London, on Dec. 4, a paper was read on "A Permanent Magnetic Field," by Mr. W. Hibbert. The author had noticed the approximate constancy of an "aged" bar magnet, and he obtained still greater constancy by attaching pole pieces to a bar magnet of such a shape as to give a nearly closed circuit of small "magnetic resistance." The pattern now described consists of a steel rod one inch in diameter and about 2½ inches long, with a cast iron disc four inches in diameter and five-eighths of an inch thick, fixed at one end. The other end is fitted in a hemispherical iron shell, which surrounds the bar and comes flush with the upper surface of the disc. An annular air space, less than one-sixteenth of an inch wide, is left between the cylindrical surface of the disc and the inside of the shell, and when the bar is magnetized a strong magnetic field exists in this space. To use this field for producing electromagnetic impulses, a coil of wire is wound in a shallow groove on a brass tube which can slide easily through the annular space, thus cutting all the lines. The tube is allowed to fall by its own weight, a neat trigger arrangement being provided for effecting its release.

The instrument exhibited had 90 turns of wire in the coil, and the total magnetic flux across the air space was about 30 C. G. S. lines. A large electromagnetic impulse is therefore obtainable, even through resistances as great as 10,000 ohms. Tests of three instruments show that there has been practically no magnetic decay in seven months. The author, therefore, considers them satisfactory, and is prepared to supply them as magnetic standards. To facilitate calculation, the number of lines will be adjusted to a convenient number, say 20,000 or 25,000.

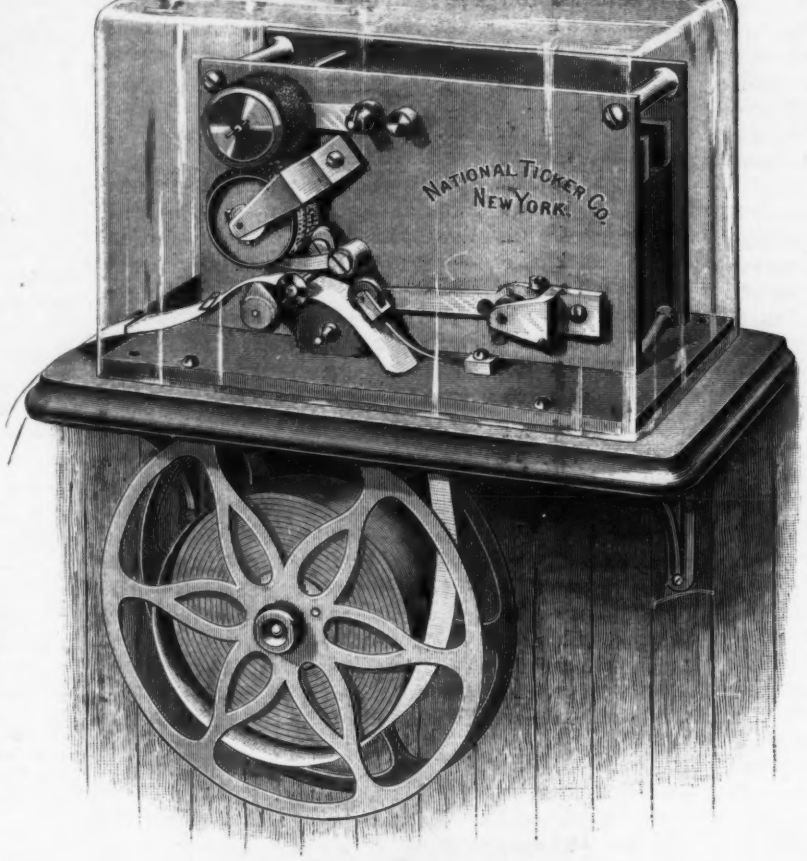
Several uses to which the instruments are well suited are mentioned in the paper, and a simple way of determining permeability by the magnetometer is described.

"C. & C." Dynamos in a Hotel Plant.

The accompanying illustration shows the dynamo room of the well appointed St. Nicholas Hotel, Cincinnati. The two generators have a capacity of 300 lights each, and are of the standard "C. & C." type. The fields of the dynamos are compound wound, and the entire machine is constructed with a view to attaining the highest possible efficiency. The armature shaft revolves in self-oiling bearings, and the whole machine rests upon a sliding base, which can be adjusted to tighten the belt. This installation was made by the "C. & C." Electric Motor Company, New York, about a year ago, and the dynamos have been in constant service since then. The fact that a 40-kilowatt dynamo of the same type has recently been added to this plant to furnish power for an increased number of lights, gives evidence of the satisfaction which these machines have given.

A New Ticker.

The accompanying illustration shows a new news reporting and quotation ticker, which is a self-winding, single wire instrument, designed for financial, commercial, sporting and general news service. It is manufactured by the National Ticker Company, of 173 Greenwich street, New York. Mr. G. A. Mott is president of the company, J. W. Taffin vice-president, and J. G. Case secretary and treasurer. The company owns and controls the inventions of M. D. Porter, and contemplates introducing the instrument in all large cities and towns in the United States and Canada.



NEW TICKER INSTRUMENT.

Small Lathe for Winding Magnet Spools.

Mr. Geo. E. Bowers, designer and manufacturer of dynamo-electric machines and electric motors, of Fitchburg, Mass., has designed a very clever lathe for winding magnets for dynamos and motors. A view of this apparatus is given herewith. Being operated by foot power, the operator has perfect control of the speed and direction in which the lathe revolves. After it has been working an hour or more, it will run practically automatic; that is, it will start or stop, revolve forward or backward at any speed desired, without giving any thought to the pedal. These lathes are now used by such manufacturing concerns as the Gamewell Fire Alarm Telegraph Company, the C. & C. Motor Company, and the Western Electrical Construction Company.

Electricity in Sweden.

The popularity of the telephone in Sweden may be seen from the following note. In a small village with only 150 inhabitants, from 60 to 80 kilometres from the nearest railroad station, the cost to each subscriber is about $52 for the line, $20 for the telephone, $13 for the first, and half of this for each succeeding year. There are merchants in this village who earn scarcely $250 a year, who feel it necessary to be connected with the telephone exchange. The exchange connects them to the railroad station and to the numerous villages in the neighborhood.

A railroad is to be built from Stockholm to Djursholm, and it is stated that if the company obtains the right to use electricity it will be employed in place of the usual steam power. It is stated that if this privilege be obtained the construction of the electric road will begin at once. The Americans will need to hurry if they want to have the credit of having been the first to replace the steam railroads by electric roads on a large scale.

An Electrical Carriage.

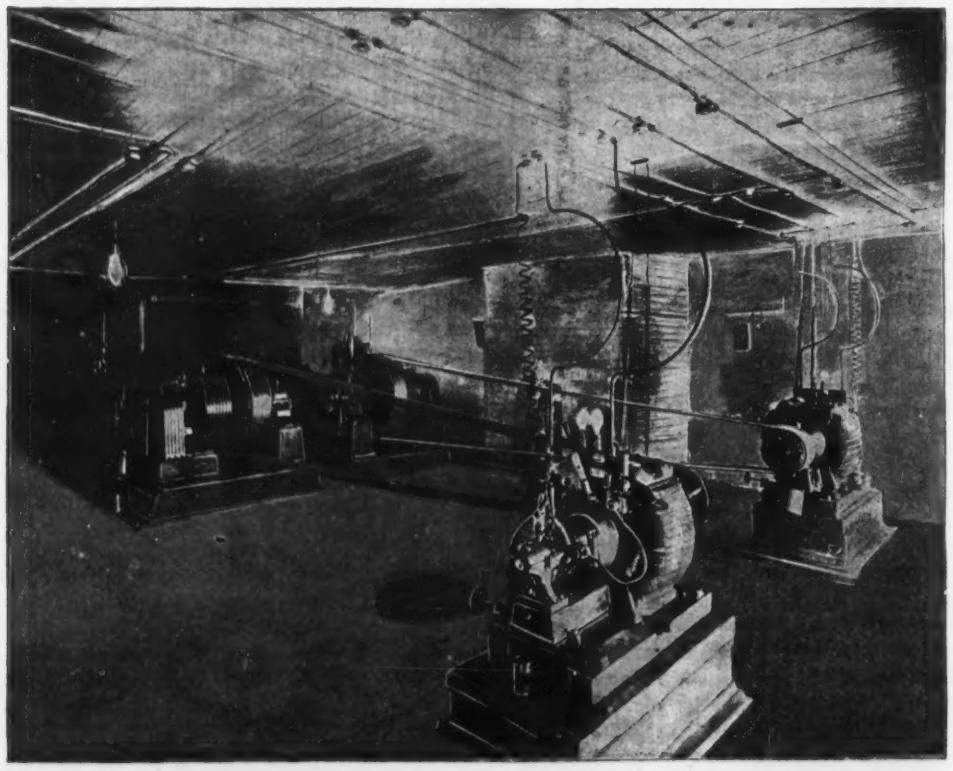
Although a carriage driven by electric power must yet be considered as an expensive luxury, there are cases in which people are willing to pay for such a luxury, and in this connection the figures given below, of such a carriage designed by Mr. Graffigny, and mentioned in a recent number of *L'Electricien*, may be of interest.

The speed of the carriage was found to be 20 kilometres (12 miles) an hour. The nature of the road was unfortunately not given, but we assume it was over the good pavements in the city of Paris.

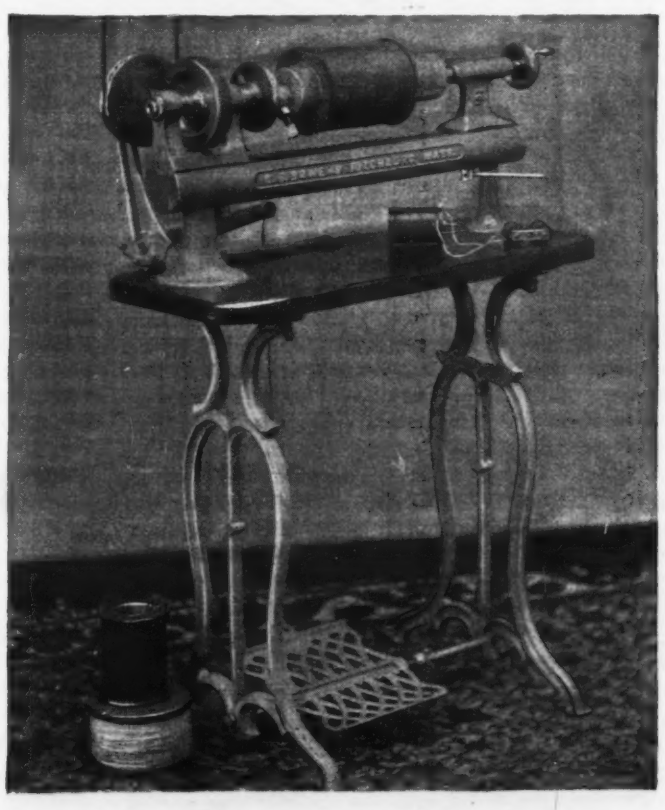
The current was obtained from a primary battery of the chromic acid type with carbon and zinc electrodes. The chromic acid used is made by a special process which is said to be very cheap. By this process the two basic alkalies of potassium or sodium are eliminated, by which it is claimed the capacity of the liquid per volume is tripled. Tests show that there can be obtained 1 kilogrammetre per second for every litre of the liquid for four hours—that is to say, for every litre of the liquid about 18,000 kilogrammetres—or that it will take about 16 litres for a horse-power hour. The consumption of zinc is given as 90 grammes per litre, or 1.4 kilograms per horse-power hour.

The carriage is a simple tricycle. The battery consists of three sets of a dozen cells each and the motor is capable of generating 20 kilogrammetres per second, which is about one-fourth of a horse-power. The current was found to be 6.2 ampères at 50 volts and the power given off at the wheels was found to be 22 kilogrammetres. After three hours the current fell to four ampères, and the power to 14 kilogrammetres, and after five hours to 7½ kilogrammetres. The weight of the carriage was about 140 kilograms (about 300 pounds), of which the tricycle itself weighed about 18 kilograms, the battery 28, the man 63, the motor 19, and the accessories 12. During a trial a mean speed of 20 kilometres an hour was obtained. In another test the machine ran 95 kilometres with one charge of the battery of 12 litres of liquid.

Assuming that one could obtain an effective horse-power hour from 75 pounds of accumulators, there is comparatively little difference between the weights of this primary battery and an equally powerful secondary battery; besides,



A TYPICAL "C. & C." DYNAMO PLANT.



LATHE FOR WINDING MAGNET COILS.

the weight of the battery in the above case was only one-fifth of the weight of the whole carriage including the man, and, therefore, a slight gain in the weight of the battery would make but a small difference in the total weight. The chief difference between using primary and secondary batteries is, that in the former case the energy, so to speak, can be bought in the drug store, while in the latter case it must be obtained from some place where an electric current is available. In the latter case there is no doubt that the cost of the energy will be considerably less, not to mention the cost of cleaning and recharging a primary battery.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Electrics as Investments.—A recent issue of the Boston *Commercial Advertiser* had the following: Electric companies have an immense, practically new field before them, and there is no reason why the securities of thoroughly well managed concerns should not be favorably regarded by investors. Large amounts of money are necessary to carry on a general electrical business, as is natural in a growing industry of its magnitude. That the three or four largest companies will eventually consolidate is considered very probable, indeed, it is said that the men in Boston and New York who are backing both the Thomson-Houston and the Westinghouse desire a union of these two interests at least. It would certainly make a strong concern, and reduce competition very materially. But these gentlemen are understood to desire it mainly from a financial standpoint.

The Closing Quotations of electric stocks on Saturday, Jan. 2, 1892, in New York and Boston were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co	100	86,200,000	84	84¼
American Telegraph & Cable	100	14,000,000	81	82½
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	149½	151
Postal Telegraph Cable	100	5,000,000	....	....
Edison General Electric	100	15,000,000	94¾	96
Thomson-Houston Electric Co.	25	6,000,000	51	51½
" " preferred..	25	4,000	26¼	26½
" International Electric Co	100	1,000,000	175	200
Thomson Electric Welding Co.	100	1,000,000	40	55
" European Electric Welding Co	100	1,500,000	15	20
Westinghouse Electric Co., assented	50	7,000,000	12½	13
Fort Wayne Electric Co	25	4,000,000	12½	12¾

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on electrical stocks as follows:

TELEPHONE STOCKS.

Chicago	$224@ $226	Cumberland	$60@ $62
Central Union	52@ 53	Wisconsin	118@ 120
Michigan	81@ 83	Bell of Missouri	175@ 180
Great Southern	30@ 32	Missouri & Kansas	54@ 56
Colorado	34@ 36	Iowa Union	20@ 22
Rocky Mountain Bell.	40@ 43		

ELECTRICAL STOCKS.

Chicago Arc Light and Power	$79@ $80	Chicago Edison Co	$139@$140

NEW INCORPORATIONS.

The Canisteo Valley Electric Railway Company, of Canisteo, N. Y., with a capital stock of $20,000, has been incorporated to operate a street surface railroad. Wm. T. Baily, Geo. L. Davis and Wm. E. Stephens, all of Canisteo, N. Y., are interested therein.

The Chicago Town Company, of Chicago, Va., capital stock $500,000, has been formed to purchase real estate, make improvements and construct electric works. J. P. Carson, B. L. Dejarnette, P. Clark, R. W. Watkins and W. P Barksdale are among those interested.

The Dulany Stock Company, of Chicago, Ill., has been incorporated with a capital stock of $300,000 to manufacture and sell, etc., electrical clocks, and other timepieces, etc., etc., motors and meters. Jas. W. Dulaney, Chas. S Perry and Chas. F. Dulaney, are the organizers.

The Crawford & Fort Robinson Motor Line Company, of Crawford, Neb., with a capital stock of $50,000, has been formed to construct a steam or electric motor line between Crawford and Fort Robinson. M. A. Manning, C. E. Ellis and Leroy Hall, all of Crawford, are the promoters.

The A. C. Robertson Company, of Princeton, N. J., with a capital stock of $50,000, has been incorporated to manufacture electrical supplies of every description and to sell same. A. C. Robertson, of Wilkes Barre, Pa., A. G. Carpenter and E. W. Carpenter, of Princeton, N. J., are the promoters.

The Breckenridge Electric Company, of Denver and Breckenridge, Colo., with a capital stock of $20,000, has been incorporated to generate and distribute electricity for light, power and heat to inhabitants of Breckenridge, Colo. Horace M. Hale, Hal Sayr, and Irving Hale are the incorporators.

The National Railway Exposition, of Chicago, Ill., with a capital stock of $10,000, has been formed to exhibit railway, electrical and other mechanical appliances and inventions, and to manufacture and sell the same. Henry Schofield, Richard A. Morrison and Albert Brodie Stone are interested.

The Dolgeville Electric Light and Power Company, of Dolgeville, N. Y., with a capital stock of $25,000, has been started to manufacture and use electricity for light, heat and power. The incorporators are Alfred Dolge, of Dolgeville, N. Y.; Edmund R. Wanckel, of New York City, and Otto Voight, of Dolgeville.

The North River Electric Light and Power Company, of New York City, with a capital stock of $200,000, has been incorporated to manufacture and use electricity for light, heat and power, in New York and adjacent towns. Henry D. Fuller, of Bayonne, N. J.; Robert Maitland, of Brooklyn, N. Y., and Henry C. Adams, of Jersey City, N. J., are the promoters.

The Royal Electric Shield Company, of Portland, Me with a capital stock of $200,000, has been incorporated to manufacture and deal in electrical appliances. Alfred E. Hill, of Somerville, Mass.; Nelson E. Hollace, of Boston, Mass., and J. Wm. Philpot, of Lynn, Mass., are the incorporators.

The Municipal Fire and Police Telegraph Company, of Kittery, Me., capital stock $250,000, has been formed to manufacture and deal in police, fire telegraphs and other electrical apparatus. The promoters are John Q. A. Brackett, of Arlington, Mass.; Moses G. Crane, of Newton, Mass., and W. M. Chapman, of Needham, Mass.

The United States Portelectric Company, (incorporated in W. Va.), capital stock $5,000,000, has been formed for the purpose of conducting the business of propelling, conveying, etc., by electrical means the merchandise and other articles of trade and manufacturing apparatus and machinery for same. Thos. L. James, John Straiton, and Abram J. Dittenhoefer, all of New York City, are the incorporators.

The Clemens Electrical Manufacturing Company, of Attleboro, Mass., with a capital stock of $25,000, has been incorporated to manufacture electrical supplies, etc., and to carry on the business of contracting and constructing engineers. Geo. Demarest, of Plainville, Mass.; Maynard E. Clemens, Attleboro', Mass.; H. G. Bacon, Plainville; M. B. Short, Philip E. Brady,, and Chas. T. Guild, of Attleboro, Mass.

The Crown Point Electric Illuminating, Heating and Power Company, of Crown Point, Lake County, Ind., with a capital stock of $60,000, has been incorporated to purchase and maintain an electric plant for the purpose of manufacturing and furnishing electricity for illuminating, heating, etc. Edwin L. Jeffrey, of Chicago, Ill.; Geo. A. Bell, Cobden, Ill., and Walter H. Tompkins, of Crown Point, Ind., are the promoters.

AFFAIRS OF THE COMPANIES.

Thomson-Houston Company.—The profits of the Thomson-Houston Company for the past ten months were $1,700,000, it is stated.

Bell Telephone Earnings, according to the Boston *Traveller*, for the fiscal year just ended will not be far from $3,098,791, or 20.7 per cent on $15,000,000 of capital stock

Oshkosh, Wis.—The Oshkosh Electric Light and Power Company has issued bonds to the amount of $100,000, and given a deed of trust to the Massachusetts Loan and Trust Company, of Boston.

Telegraph Dividends.—A dividend of 2 per cent. has been declared on the stock of the Mexican Telegraph Company, payable Jan. 16, and a dividend of 1¾ per cent. on the stock of Central and South American Company, payable Jan. 9.

The Thomson-Houston Company, it is stated, have decided to erect a big electric plant at Pullman, Ill., which will cost nearly $500,000, and will employ about 1,000 men, and it is stated that negotiations are now pending between the company and the Pullman company for the purchase of the site. Four sites are under consideration, two of them north of the Pullman works and two of them south.

Cœur d'Alene City, Idaho.—W. T. McCaskey, agent of the Edison General Electric Company, of Spokane, has associated with him S. T. Wills, of Warden, Idaho, and has purchased the plant of of the Cœur d'Alene City Illuminating Company. It is stated that the purchase price was $9,000. Extensive improvements in the plant will be made, a line being extended throughout the entire city. The manager of the new company will be Mr. B. Mahlum.

The Westinghouse Electric Company has greatly reduced, it is said, the working force in its office, and further changes are contemplated. Among the officials who have retired are assistant treasurer W. L. McCullough, purchasing agent W. G. Lindsay and chief shipping clerk Samuel W Harper. It is said that the changes have been made at the instance of the new management. It is rumored that the new Westinghouse electric stock to be issued for the assented stock is likely to be put out soon. It is estimated that the company is now earning, on the basis of $3,000,000 for the year, $600,000 net, or seven per cent. on the $3,000,000 of preferred stock and 6½ per cent. on the $5,000,000 of common, or about 15 per cent. on a price for the new stock which would be equivalent to 12½ or 13 for the old stock.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Jan. 4, 1892.

The Greenwich (N. Y.) Electric Light and Power Company is improving its plant. Among the improvements is a 30-inch horizontal turbine constructed by the Swain Turbine and Manufacturing Company, of Lowell, Mass.

The New York Sun has withdrawn from the Associated Press, leaving as members in that body the *Times*, *Tribune*, *Herald*, *World*, *Journal of Commerce* and *Mail and Express*. Disagreements among the members was the reason for the *Sun's* action.

Electric Hoisting Plant.—The Thomson-Houston Company has recently put in the largest electric hoisting plant in the country at the docks of the Wilson Steamship Company at Brooklyn. There are nine hoists designed to carry or lift 3,000 pounds.

Mr. E. C. Bradley, formerly manager of the telegraphic department of the Pennsylvania Railroad, with headquarters at Pittsburgh, has been appointed general manager of the Postal Telegraph Cable Company. Mr. Bradley took charge of his new work on Jan. 1.

Electrical Society's Lecture.—Mr. A. A. Knudson delivered a lecture at last week's meeting of the New York Electrical Society on the subject of "Frauds in the Electrical Business," relating some of his own experiences in exposing frauds and suggesting remedies for evils of this kind in the electrical business.

Mr. R. G. Brown, the well known electrical engineer of this city, has just been married to Dr. Lucy M. Hall, at the residence of Clara Barton of the Red Cross Society in Washington. Mrs. Hall-Brown has had a distinguished career as a physician. Mr. Brown is the author of the book, "System Central Téléphonique en France."

Mr. W. S. Hill, president; Mr. Geo. H. Poor, general manager, and Mr. Ernest A. Des Marets, New York agent of the W. S. Hill Electric Company, of Boston, held a pleasant little "At Home" in the company's New York branch in the Electrical Exchange Building, this city, on Monday of this week.

New Year's Eve at the Electric Club.—Members of the Club who were absent from the entertainment at the Club House in East Twenty-second street, on New Year's Eve, missed a rare treat in the informal address of Mr. Joseph Howard, Jr., who talked upon the subject of "Journalism." An especially fine musical programme was arranged for the entertainment of those present. The social features of the evening were not the least prominent, as every one present seemed intent on making the best evening of the year a memorable one.

The Edison Illuminating Company, of Coney Island, has just been incorporated, with a capital stock of $50,000, to furnish light, heat and power in and about the vicinity of Coney Island. The whole district covers not only Coney Island but Gravesend, New Utrecht, Bensonhurst and neighboring towns. The incorporators are Manuel Plaisantin, Josephine V. Cook, and Eugene de Frere, all of Brooklyn. It is expected that operations will be begun immediately, the starting point being West Brighton, from which the service will grow into the outlying districts.

Vetoed the Trolley.—Mayor Boody, Brooklyn's new Mayor, has vetoed the resolutions passed by the Board of Aldermen Dec. 21 authorizing the several railroad companies to substitute the overhead trolley system for horse power. But for his veto, the resolutions would have become a law by limitation at midnight Jan. 2. There is a difference of opinion as to when the ten days' limitation expired. The resolutions were sent to Mayor Chapin on Dec. 23. The City Clerk of Brooklyn and several of the Aldermen contend that Sundays and holidays were not included, and that the ten days do not expire until Wednesday, Jan. 6. Ex-Mayor Chapin holds that Sundays and holidays should be counted. It is stated that all Aldermanic unsigned resolutions in the hands of the Mayor at the expiration of his term "died" when the Mayor went out of office. Mr. Boody asked the opinion of Corporation Counsel Jenks on both these questions, who held that Sundays and holidays must be included in the ten days' limitation affecting the minutes of the Aldermen, and that in the case before him the limit expired at midnight Jan. 2.

The Tropical American Telephone Company, Limited, has removed its executive and business offices to 95 Broad street, rooms 303 and 304. The removal was made necessary by the large increase in the export business of the company, which has been steadily growing, and in order to be more in the centre of trade, the bulk of its trade being with New York exporters, and the bulk of its shipments being made from the present quarters. Foreign orders can be sent with more advantage from New York than Boston, and the stock of goods formerly kept at Boston will be discontinued, and New York and Baltimore hereafter will be the shipping points, the only offices of the company being in this city. Mr. Chas. Williams, Jr., has resigned as president and director of the company, although still retaining his interests as a stockholder, his retirement being rendered necessary on account of his continued absence abroad. The company has established recently several depots of supplies, among them one at Cienfuegos, Cuba, with Mr. Louis Elminger as selling agent, also one at San José, Costa Rica, in charge of Villafrauer Bros. & Co.

Mayor Grant on the City's Electric Service.—In his annual report, published to-day, the mayor says: "The decrease in fatal accidents resulting from overhead wires, despite the great increase of electrical business, is an evidence of the wisdom of the efforts made by this administration to place the wires underground. One fatal accident, in which death was caused by a fall from a telegraph pole, is the record of the year. In 1889 five deaths from actual electric shock were reported. There has also been a noticeable improvement, especially in the lighting service, from the use of the subways. The year's work under the Board of Electrical Control comprises the removal of 5,224 poles and 7,152¼ miles of wire, and the construction of 114 miles of subways. The capacity of this subway work is as follows: Forty-seven miles for electric light service, 721 miles for telephone and telegraph service, and 121 miles for Edison light service. There are now in use in the city 1,420 miles of subways, divided as follows: Electric light subways, 578 miles; telephone and telegraph subways, 721 miles, and Edison subways, 121 miles. There are at present 59 alternating and 84 arc circuits, making a total of 143 high tension circuits in use in the subways, with 528 miles of electric light conductors. There are 29,666 miles of telegraph and telephone wires, 383 miles of Edison conductors. The reports are conclusive that from an electrical standpoint the operation of the subways is a success." His honor recommends the establishment of a municipal telegraph exchange to connect the departments and certain other points. L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, Jan. 2, 1892.

W. H. Weston & Co., Philadelphia, report business in their line as good. This enterprising firm has just completed a new style of switch.

The advantages of the use of electricity as a motive power were recently referred to in the following manner by the Philadelphia *Record*: "That electricity furnishes the ideal motor for rapid transit in the large cities there can no longer be a question."

The Philadelphia Illuminating Company has filed in the Court of Common Pleas a bill against Director Windrim to restrict him from awarding contracts for electric lighting during 1892, on the ground that they have not been given to the lowest bidders. The contracts were awarded to the Brush and other companies about two weeks ago.

By Trolley Wires.—Permission has been granted for the erection of trolley wires in Philadelphia, and it is stated that early in the coming spring the Philadelphia Traction Company expects to have cars running by electricity on many of its lines in the city. The citizens are evidently determined to have better transit facilities.

Mr. Otis K. Stuart, representative of the Germania Electric Company, of Boston, has opened an office in the City Trust Building, Philadelphia. Mr. Stuart will carry a full line of electrical supplies, including the well known Germania lamp. His office will be southeastern headquarters for all the Germania Company's specialties, including transformers, shade holders, sockets, etc. Purchasers will consult their interest by getting quotations from Mr. Stuart.

Against the Lease of the Traction.—It is stated that the meeting of the stockholders of the Thirteenth and Fifteenth street passenger rail way, to be held in this city Jan. 11, is likely to be a lively one, and that the majority of the stockholders are against ratifying the lease of the lines to the traction people, on account of decrease in dividends, etc., and that leading stockholders have put in a very vigorous protest against the action of the directors in contemplating the lease.

The Equitable Engineering and Construction Company, Drexel Building, Philadelphia, announces that on the first of January the company went into liquidation. Its business for the past year has been a profitable one, but the active members of the concern wish to get out of the construction business. Mr. S. Ashton Hand has accepted a position as superintendent of the Detroit Electrical Works, Detroit, Mich., and Mr. W. A. Stadelman wishes to devote his time for the present to his interests in Bristol, Tenn., which consist of the Bristol Belt Line Railway and the Bristol and East Tennessee Railroad, in both of which he owns a controlling interest. The company retired from business with every debt paid and a good balance to be distributed as a dividend to the stockholders.

The Isolated Department of the Thomson-Houston Electric Light Company, of Philadelphia, of which Mr. Chas. K. Westbrook

has been manager for the past 18 months, reports a remarkable increase of business in that department, the same amounting to about $75,000 for the six months ending Dec. 31, 1891. Among very recent sales are the following: Edward T. Steel & Co., Bristol, Pa., 1,200 incandescent; W. C. Hamilton & Sons, Philadelphia, 500 incandescent; Martin, Fuller & Co., Philadelphia, 375 incandescent; Philadelphia & Reading Coal and Iron Company, Pottsville, Pa., 35 arc; Pencoyd Iron Company, Pencoyd, Pa., 50 arc; South Baltimore Car Works, Baltimore, Md., 35 arc; B. & O. Railroad Company, Brunswick, Md., 25 arc; Delaware Hosiery Company, Dover, Del., 250 incandescent; Penn. Supply Company, Wilkesbarre, Pa., 90 incandescent; Stinson Bros., Philadelphia, 45 arc; Cayuta Wheel Foundry Company, Sayre, Pa., 125 incandescent; Boyd, White & Co., Philadelphia, 18 arc; Shoneman & Bros., Eighth street, 6 arc; and a 75 incandescent plant for use on the boat of the Board of Police Commissioners at Baltimore, Md. W. R. W.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Jan. 2, 1892.

The Pettingell-Andrews Company is distributing as usual its annual calendar.

The Eastern Electric Supply Company has issued a very neat calender which is ready for distribution.

The Hall patent electric cut-off, of Lowell, Mass., will hereafter be manufactured by the Baker Telephone Index and Tablet Company, of that place.

Mr. Armington, of the Holtzer-Cabot Company, who has been laid up for some time with la grippe, has resumed his place in the office, although not yet entirely recovered.

The Ashton Valve Company has sent out a very handsome calendar for 1892, the subject for the steel plate being taken from a painting called "The Dawn of the New Year."

Mr. Charles A. Scott, representing the Union Switch and Signal Company in Boston, died Wednesday of this week. Mr. Scott has been long and favorably known in New England.

The West End Street Railway will, it is understood, soon adopt a new fender for its electric cars. The next route to be operated by electricity is the South Boston & Chelsea Ferry line, which will be ready in a few days.

The Electrical Specialty Company, of Pawtucket, has been awarded a gold medal at the Southern Electrical Exhibition just closed at Augusta, Ga., for the best arc light cut-out switch, as well as other medals for carbon brushes and load transferer.

Mr. Francis R. Hart, of the Massachusetts Electrical Engineering Company, read a very interesting paper on "Long Distance Transmission of Power by Electricity" at the Massachusetts Institute of Technology Tuesday night. The paper went into the subject very thoroughly and showed that Mr. Hart had given the matter the attention to which it was entitled, and that he was entirely competent to handle it.

An exhibition of the Hubbell portable battery in the office of the Consolidated Motor Company, Boston, on Tuesday, was made in the presence of representatives of the press and others. A portable lamp and battery, the whole being 4½ × 6 inches, weighing four pounds, burning a 3-c. p. lamp, was shown, together with various others for running sewing machines, fans, dentists' lathes, etc. It is very probable that a company will be formed here and that the Consolidated Motor Company will handle the business in New England. C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Jan. 2, 1892.

Gen. A. H. Barney dined at the Chicago Electric Club this week.

Mr. W. A. Crowdus is receiving many callers at his room, 562 Palmer House, Chicago, where he has a most interesting electrical exhibit.

Judge John J. Swenie, late the private secretary of John P. Barrett, received as a Christmas present from his former comrades in the city fire alarm service a bound copy of the Century Dictionary, which will now adorn the library in his handsome law office.

Major C. A. Benton, more rotund and jovial than ever, was one of the welcome visitors in Chicago this week. Small wonder that the railway department of the Detroit electrical works is crowded with business with such a happy manager at its head.

Mr. George E. Fisher, manager of the Commercial Electric Company, was in Chicago this week arranging for the necessary apparatus to complete the installation of two extensive electric plants, the orders for which were received in time to be considered Christmas presents.

Mr. G. W. Regester, of the Electro-Dynamic Company of Philadelphia, stopped over in Chicago for a few hours, en route from Dubuque, Ia., to Philadelphia. For nearly a year, Mr. Regester has looked after the electrical end of the storage battery street railway system in Dubuque, and has managed to keep the cars in operation under circumstances that were often of the most discouraging character. Mr. Regester's many friends will be glad to welcome him home again.

The Chicago Electrical Association.—At a meeting of the Chicago Electrical Association, Dec. 22, Mr. A. H. Adams read a paper upon "Chimneys and Chimney Draughts." Mr. L. G. Bassett also read a paper upon "The Speed of Electricity." The following officers were elected for the six months beginning Jan. 12: President, E. G. Herey; vice-president, J. F. Conner; secretary, F. R. McBerty, No. 227 South Clinton street; treasurer, Albert Scheible. This association meets fortnightly at No. 169 Washington street.

The Chicago Electric Club held another of its social meetings on Monday evening, Mr. F. E. Degenhardt presiding. Prof. F. B. Badt and Mr. W. J. Buckley each read a little skit on the query: "Is it true what electricity is?" Mr. Fowler related some stories and Mr. M. M. Chase and Mr. E. C. Loveland favored the members with instrumental music that was well received. The announcement was made that the club's finances were never in better condition and that the large daily attendance at the noon lunch insures the success of the kitchen.

The Chicago Herald.—Mr. James W. Scott, the publisher of the Chicago *Herald*, tendered an informal reception to the newspaper men on Tuesday, Dec. 29, to enable all to inspect the many innovations embodied in the *Herald's* new home on Washington street. Electricity plays an important part in both the decorative lighting effects and in driving the great presses. As a whole it is a cosy, unique, convenient and comfortable commercial home and a worthy monument to the ability of the man who placed the *Herald* in the front rank of the great dailies.

Mr. Charles E. Gregory, late general sales agent of the Sperry Electric Company and the Standard Electric Company, of Chicago, and formerly clerk of the Electric Court, will open a depot at 207 South Canal street, for the purchase and sale of second hand electrical apparatus and steam plants. Mr. Gregory's wide experience in installing, operating and managing large electric plants under varying conditions peculiarly fits him for the new line of business he has laid out, while his wide acquaintance and well known ability as a hustler insures success from the start.

Mr. F. S. Terry, manager of the Electrical Supply Company, in an article in the Chicago *Morning News* on the year's progress in electricity, gives some telling arguments in favor of a more extended application of electricity in all its branches, "from the tiniest household convenience to the largest enterprise to which power is applicable." The improvements in the construction of motors of large horse power lead him to predict that in a few years all the power in large cities will be disseminated from a central station, while mills, factories and machine shops will possess individual motors. The popularity of electricity in the household is demonstrated by his statement that 75 per cent. of the houses now being erected are wired for communicators and call-bells, as well as for electric gas lighting, where the use of the incandescent lamp is impracticable. Mr. Terry adds that owing to the immense amount of capital required by electrical supply houses there seems to be a movement toward centralization by a number of large concerns. The disappearance of smaller houses is due to this concentration of capital.

Electric Lighting at the World's Fair.—It is stated that every electric firm of any consequence in the country will be given an opportunity to bid for the electric lighting at the Exposition Buildings and Grounds. Provision has been made for an electric lighting capacity of 15,900,000 c. p.; this will be more than twice the volume of electric light now furnished for Chicago. In order to furnish this illumination there will be employed 7,000 arc lights of 2,000 c. p. each, and 120,000 incandescents of 16 c. p. each. The plans for the electric lighting have been completed by Electrical Engineer Sargant and Chief Barrett, of the Department of Electricity, and bids will be asked for the installation of the entire plant this week. The ultimate plans call for the use of more than ten times the amount of electric light used at the Paris Exposition. All the lagoons and canals will be lighted, and the facades of the buildings surrounding the Grand Plaza, in which will stand the Administration Building, are to be aglow with incandescent lights. Each of the 14 buildings in process of construction will be lighted by different contracts, and the grounds have been so divided into sections as to make it possible for fifty different firms to engage in the bidding.

The Artistic in Window Display.—The Illinois Central suburban service carries an average of over 20,000 passengers daily from its main depot near Randolph street, to reach which three-fourths of the number pass the corner of Randolph and Michigan avenue, where stands the immense warehouse of the Electrical Supply Company of Chicago. During the holiday week its great corner show window was so artistically draped that it is reasonable to assume that fully 90 per cent. of the passers-by gave something more than a hurried glance; and each probably exclaimed "how beautiful!" From the ceiling depended an evergreen canopy in the centre of which hung a large bell made of the same with a clapper formed of a Sunbeam lamp inclosed in a pearshaped etched glass globe, and around the rim of the bell miniature colored incandescent glow lamps were partially concealed. Beneath this bell was a rustic fountain, built of rocks and porcelain insulators, projecting a stream some three feet in height, the spray falling over colored Sunbeam lamps. Around the base of the fountain and covering the entire floor of the wide window, evergreen and white cotton to represent snow was artistically blended, while acorn incandescent lamps of various colors were scattered through the foliage and the holly and mistletoe depending from the walls. Taken as a whole, with the lamps burning day and night, it was one of the most beautiful displays ever seen, and the tasteful arrangements of the many specialties manufactured by The Electrical Supply Company enhanced the attractiveness of the exhibit. F. DE L.

News of the Week.

THE TELEPHONE.

A Telephone Exchange is being projected at Austin, Minn.

New Berne, N. C.—A franchise has been granted to O. H. Guion and W. W. Clarke for constructing a telephone line.

Trinidad, Colo.—The contract for the construction of a telephone line from Trinidad to Forbes and Victor has been let. The line will be 19 miles in length, and will give Trinidad telephone connection with Pueblo and Denver.

Newport News, Va.—The York Telephone and Telegraph Company has been incorporated with T. H. Gordon, president; William Lamb, of Norfolk, vice-president, and R. G. Bickford, secretary, and has privilege to construct telephone lines in certain counties of Virginia. The capital stock is to be not more than $30,000.

The Chesapeake & Potomac Telephone Company.—President Bryan, of the Chesapeake & Potomac Telephone Company, called on the commissioners of the District of Columbia recently, and said the telephone service supplied the residences of the commissioners at $50 each yearly was furnished at a loss, and it would be necessary to raise the tolls. The commissioners didn't think they should pay any more, as it was an agreed-on price, and that was all there was about it.

A rather peculiar incident recently occurred a short distance outside of Riverside, Cal. A telephone wire of the trust company broke between two offices, about 15 miles apart, and yet an ordinary conversation could be carried on over the wire after it was broken, though the magneto bell would not ring. There being no other wire on the same poles at that part of the line where the break occurred it is supposed that the current was carried between the ends of the broken wire through wet ground. A few feet below the surface there is what is known as hard pan, which possibly acted to some extent as an insulator between the upper and lower strata of earth.

Albany, N. Y.—Mr. William H. Cull, the electrician of the Hudson River Telephone Company, has returned from Richmond, Va., after a vain attempt to reconcile the Law system of telephoning with the wants of the Hudson River Telephone Company. It has now been definitely decided to adopt an entirely new system made up of the best features of the standard systems. Electrical experts are now at work devising a switchboard of this character. Manager Uline says that the new building will be ready by May 10. The offices of the company will be removed to the new building at that time, but it is not expected that the present quarters will be vacated before July 1 or even later. The present building has been leased for another year.

THE ELECTRIC LIGHT.

Madison, N. J.—The new electric light plant is now in operation.

Wichita, Tex.—An electric light plant will shortly be established.

Mobile, Ala.—Electric lighting is in contemplation. The mayor can give information.

Calvert, Tex.—Messrs. Allen, Collat & Fuller are considering erecting an electric light plant.

Reed City, Mich.—It is expected that the electric light plant will be in operation about Jan. 1.

Franklin, Va.—An electric light plant will be put into the works of the Franklin Lumber Company.

Henderson, N. C.—The City Council is inviting proposals for the establishment of an electric light plant.

Monroe, N. C.—The American Construction Company has secured a franchise to erect an electric light plant.

Raleigh, N. C.—Arrangements are now making for the installation of an electric light plant in the insane asylum.

Wheeling, West Va.—An isolated incandescent plant will be put into the factory of the Bloch Bros. Tobacco Company.

Charleston, S. C.—It is stated that the West End Railway Company contemplates putting in an electric light plant.

Batesville, Ark.—Franchise has been obtained by the American Construction Company to erect an electric light plant.

Greensboro, N. C.—Bids will be received until Feb. 1, 1892, by James M. Forbes, Mayor, for lighting the town by electricity.

Dardanelle, Ark.—Franchise for the erection of an electric light plant has been obtained by the American Construction Company.

Brunswick, Md.—The Baltimore and Ohio Railroad Company's electric light and power plant, reported as being burned, will be rebuilt by E. Brady & Sons.

The Thomson-Houston Electric Light Company has begun the erection of its new station at Mitchell, S. Dak. The company has heretofore secured power from the roller mills, but on account of the large increase of lights put in during the fall, it was found necessary to add a boiler and engine of larger capacity.

THE ELECTRIC RAILWAY.

Atlanta, Ga.—Work has commenced on the Atlanta & Chattahoochee River Railroad.

Spartanburg, S. C.—The Spartanburg Bell Electric Railway Company has applied to the legislature for a charter.

Fort Worth, Tex.—The proposed electrical railway from Fort Worth to Dallas will be surveyed by F. Boals, of Arlington.

Anniston, Ala.—Arrangements have been consumated for equipping the Anniston street railway with electrical apparatus.

Velasco, Tex.—The contract for building the Velasco and Surf Side Railway has been awarded to Downey Brothers, of Houston, Tex.

Bolton, Ga.—An electric power plant will be erected near by the Atlanta & Chattahoochee River Electric Railway Company, of Atlanta.

Charleston, S. C.—Work has commenced on the West End Railway Company's electrical railway. E. J. White is in charge of the construction.

Yonkers, N. Y.—The petition of the Yonkers Railroad Company to change its motive power from horses to electricity has been granted by the Common Council.

Baltimore, Md.—Electrical equipment for the South Baltimore & Curtis Bay Electrical Railroad will be furnished by the Edison General Electric Company, of New York.

Lansingburgh, N. Y.—A system of electric lighting is being placed in the residence of George W. Daw, of Lansingburgh. This will be the first residence in the village to be lighted by electricity.

Eureka Springs, Ark.—One and a half miles of additional track have been added to the Eureka Springs Electric Light and Street Railway, and its lines will be changed to electricity June 1, 1892.

Alexandria, Va.—D. E. Leach, of New York, is president, and S. W. Speer, of Duluth, Wis., secretary and treasurer of the Alexandria & Fairfax Passenger Railway Company, lately organized. Work will shortly commence on an electrical railroad.

Utica, N. Y.—The attachments against the Belt Line Street Railroad Company, of Utica, granted in favor of Munson Bros., W. W. Fowler and Childs and Jones, have been settled by the plaintiffs accepting the face value of their claims without costs.

Fall River, Mass.—It is expected that within a short time the Globe Street Railway will pass into the hands of the syndicate which recently purchased it, and that the establishment of an electric plant will be commenced within a very short time.

The application for the trolley system electric railway franchise from Port Richmond to Prohibition Park, S. I., was recently given a public hearing before the Board of Trustees of New Brighton, S. I. The contract will be drawn up and presented to the trustees for their approval at their meeting this week.

Ballston Spa, N. Y.—There is every prospect that an electric railroad will soon be constructed from Ballston Spa to Rock City Falls, a distance of seven miles. The chief promoter of the scheme is Abijah Comstock, president of this village. Mr. Comstock will investigate electrical science in the Edison works at Schenectady.

Blountville, Tenn.—A survey will be made at once for the proposed electrical railroad from Blountville to Bristol, a distance of eight miles, and it will probably be built. The survey will be made by W. A. Stadelman, of Philadelphia, president, and S. G. Nicholson, of Bristol, superintendent of the Bristol Belt Line Railway Company.

Asheville, N. C.—The electric street cars do a more varied business than is done on cars in any other part of the country; they carry passengers, and mail and express matter, and to this have added the handling of tobacco from the warehouse. The right of the company to construct a line on the street on which are the warehouses is a question now before the Supreme Court.

Lowell, Mass.—The proposition to build an electric street railway between Lowell and Haverhill through Lawrence is said to have taken tangible shape, and it is also stated that a petition will be presented to the incoming Legislature praying for charter rights to construct the road, and for right of way. It is said that the road will cost $600,000. Boston capital is interested.

A Trolley Road from Jersey City to Newark.—It is stated that the Pennsylvania Railroad Company has projected a trolley line from Jersey City to Newark, and the work upon the same will be started at once. It will join the Market street and Irvington line in Newark to the Jersey City and Bergen electric road, and will pass through four and one-half miles of open country. It is understood that the road will be used to demonstrate the advantages of electric trolley propulsion over locomotives, and that the maximum of speed will be attained in crossing the meadows. The distance from the ferry to Irvington is twelve miles, five miles of which is through the crowded parts of Newark and Jersey City, and the rest is territory in which high speed will be allowed.

Industrial and Trade Notes.

The Albany Railway is still experimenting with a car heater stationed on the platform. It has not been very satisfactory, as there has not yet been the cold weather necessary for a good test.

The Star Electric Company, Philadelphia, is introducing its new style of china switches, some of which are very attractive. The company is also carrying a line suitable to the finest class of work.

Wm. T. Pringle & Co., Philadelphia, report business for their specialties as good, especially their New Era Candle, which has met with a large sale. They also manufacture a line of handsome fixtures.

The Electric Appliance Company, 242 Madison street, Chicago, has issued a neat pocket catalogue of various specialties it is handling, and shortly will issue a complete catalogue of electrical supplies and also of railway supplies.

H. T. Paiste, 10 South Eighteenth street, Philadelphia, manufacturer of electrical specialties, is sending out a very neat calendar for 1892, with his compliments to the trade. It bears on the reverse several illustrations of the well-known switches which he manufactures.

Messrs. E. Leonard & Sons, of Vancouver, B. C , write to say that the Ball compound engines in the New Westminster street railway plant are developing far beyond the guaranteed horse power. They have been running steadily for the past three months 18 hours per day.

John E. Beggs, of 74 Cortlandt street, New York, dealer in new and second hand electric supplies, reports business first class, and has recently furnished the supplies for increasing the capacity of several large electric light plants, and has a large number of contracts in contemplation.

The Engineering Equipment Company reports some sales of Habirshaw wire aggregating 59,000 feet as showing that they are now considered in a position to handle this well known wire at manufacturer's prices. The company is very close to the factory on each of the steam and electric specialties it handles.

The Commercial Electric Company, of Detroit, Mich. has recently completed an incandescent plant of 1,400-light capacity, of the National Transformer system, for the city of Coldwater, Mich.; also a plant of 100 arc lights of the Standard system for Pontiac, Mich., and one of 40 arc lights for the city of St. Ignace, Mich.

The Gilbert Car Works, of Troy, N. Y., owing to large orders received recently, will enlarge its shops. It has been decided to convert the sheds back of Cannon street into a workshop where cars partly constructed may be operated upon in minor details while the finishing process is going on in the present building. The addition to the foundry has been completed.

Desk Calendars.—The Nubian Iron Enamel Company, of Cragin, Ill., are sending out their desk calendar for the new year, and will mail one free to any one sending his address. These calendars are issued quarterly, and the quotations and the wise remarks Mr. Bonnell has had printed at the top of the various pages make it the best cure for dyspepsia now on the market.

Mr. J. Holmes, of 74 Cortlandt street, New York, dealer in electric supplies, reports meeting with the best of success in his business. Mr. Holmes was formerly with E. S. Greeley & Co., and the Western Electric Company, and since being in business for himself has worked up a large trade, which is constantly increasing. He is popular in his line of business and well-known for his enterprise and his ability.

Moore Electrical Manufacturing Company, of 652 Hudson street, New York, manufacturers and dealers in general electrical supplies, have recently issued an illustrated catalogue and price list of nearly 100 pages, which gives a large amount of information in regard to the class of goods manufactured and handled by this company. It is neatly gotten up, and is a credit to the enterprise of the company.

The copartnership heretofore existing between the firm of Magie Brothers, of Milwaukee, Wis., was dissolved by mutual consent on Dec. 15, Messrs. Wm. A. Magie and Frank O. Magie continuing the business. This firm manufactures lubricating oils and journal lubricants. The Milwaukee and Chicago houses of the firm have been consolidated, and hereafter will be located at No. 409 South Canal street, Chicago.

The Electrical Supply Company, Chicago, is receiving a great many orders for its Wirt dynamo brush. Engineers who have used it speak in the most enthusiastic terms of its good qualities, and say that they would not like to be compelled to use the old style again. The Electrical Supply Company say that each set is made especially for the station ordering, and in this way they meet the exact conditions of service, thus giving the highest results. The brush is said to entirely prevent the usual sparking and wear on the commutator.

The Roessler & Hasslacher Chemical Company, of 73 Pine street, New York, manufacturers of Isolatine paint for outside and inside electrical work, reports meeting with the best of success, and a constantly increasing trade. Isolatine is always pliable, permanently protects the work, and is of the highest insulation. It has been tested and found to be water and weather proof, gas, acid and alkali proof, and it is stated furnishes the same protection of iron against rust and wood against rot. It produces a polished, black surface wherever used, dries quickly and does not peel or crack, and covers enormously,

Engine Sales.—The engine department of the Racine Hardware Manufacturing Company, Racine, Wis., has just sold the Terre Haute Brewing Company, Terre Haute, Ind., one of its 30-h. p. high speed engines: to the St. Joseph (Mich.) Iron Works a 25-h. p.; to the Janesville (Wis.) Woolen Mills a 30-h. p.; to a large cooperage works at Peoria a 20-h. p.; Augusta (Ga.) Brewing Company, a 10-h. p., for running electric light plant. The company reports additional sales from points in Texas, Louisiana, Michigan, Illinois, Kansas and Missouri. It has doubled the equipment in the engine department and regards the outlook for the immediate future as very good.

Any one happening into the busy store of the Electric Appliance Company during the last week of December would have wondered at the unusually busy appearance of the place, which at no time since the new firm started has been anything but busy. If you had stopped to inquire the cause you would have been informed that the president of the company, Mr. Willard W. Low, had just returned from a business trip, and any one familiar with the *personnel* of the Electric Appliance Company knows what that means. Mr. Low filled the Electric Appliance Christmas stocking with orders that made holiday week a very restless one for the employés of the company, and a merry one for the firm.

The Easton Electric Company, of Brooklyn, N. Y., lately sold to the Messrs. J. S. & G. F. Simpson, of 28 Rodney street, Brooklyn, N. Y., a 600-light incandescent plant, consisting of a No. 9 Easton incandescent dynamo, and the lamps. The plant includes a number of the Easton arc lamps which are operated on the incandescent circuit. The entire installation was made by the Easton company, and was pronounced a success The plant is in daily operation on the premises owned by the Messrs. Simpson, and gives entire satisfaction. This is the sixth large plant which the Easton company has lately installed in Brooklyn. This fact is good evidence that the work of the company is appreciated at home.

Sales of Belting.—Recent sales aggregating 16,200 feet of Underwood cotton leather belting of various widths, ranging chiefly between 2 inches and 24 inches, are reported under date Dec. 21 by the Engineering Equipment Company at its New York salesroom, 143 Liberty street. These sales are exclusive of direct factory orders and do not include the Western or foreign trade, nor the sales of the Boston office. This looks well for cotton leather, despite the assertions of those who claim, for business purposes, that the Underwood belting is not what it is. There is enough to show it is true that the cotton leather belting, made by the Underwood Manufacturing Company, is steadily, and in some directions rapidly, growing in favor with the users of belting. The present product of the Underwood factory is of high grade in point of excellence of material and manufacture. The significant sales figures given indicate the value of this belting and suggest its use to those who have not tried it recently. The Engineering Equipment Company is the authorized selling agent, under contract, for the Underwood Manufacturing Company.

W. R. Fleming & Co., 174 Fulton street, New York City, representing the Harrisburg Foundry and Machine Works, are installing the Harrisburg Ide and Ideal engines, as well as complete plants. The following are a few of the recent orders they have taken: For the H. W. Johns Manufacturing Company's new factory, South Brooklyn, two 125-h. p. horizontal steel single return tubular boilers; Philip Daly's Pennsylvania Club House, West End, N. J., a complete plant of 60 h. p.; Duncllin Electric Light Company, Bound Brook, N. J., complete plant of 35-h. p.; Mr. Luther C. White, Waterbury, Conn., one 25-h. p. Ideal engine; Hotel Marlborough, New York City, one 100 h. p. Ideal engine; Mr. Jacob Rothschild, Fourteenth street, New York City, one 35-h. p. Ideal engine; Hotel Endicott, Ninth avenue and Eighty-first street, two 100-h. p. Ideal engines. All of these contracts for engines were made with most rigid guarantees that the engines would run noiselessly and without vibrations. These people make a specialty of this class of work, appreciating how important it is that there should be no noise or vibration whatever in plants for hotel and apartment house service.

The Providence Steam Engine Company, of Providence, R. I., which makes a specialty of manufacturing engines for electric lights and street railway work, has recently completed a compound engine to run 108 revolutions per minute and to develop from 500 to 1,000 h. p. for the Thomson Houston works at Lynn. The engine is designed particularly for testing the large dynamos which are being constructed for the West End Railway Company of Boston, which will be the largest in use in this country, but will also be used for supplementing the engines which this company put in the works some years ago. Compound condensing engines are also being erected by this company at the station of the United States Electric Company in Washington, D. C., of 500 and 250 h. p. each. It has also put into operation for the West End Electric Company, of Philadelphia, two engines of 450-h. p. total, and for the Diamond Electric Company of the same city three engines of 700 h. p., and is now also erecting for the Frankfort Avenue Merchants' Electric Light Company, of Philadelphia, an engine of 300 h. p. It has also built and put in operation in that city recently 1,800 h. p. of engines for electric lighting.

Electrically Equipped Machine Shop.—In line with the policy of the Detroit Dry Dock Company to keep up to the times and have the most economical appliances, the Dry Dock Engine Works has closed a contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for a new fireproof modern machine shop, which will enable the company to build the largest engines with the least expense and in the quickest possible time. The building when complete will be the finest machine shop on the great lakes and will compare favorably with any in the country. The plant will have modern appliances, such as electric cranes, two of 20 tons' capacity running the whole length of the building, new machinery, electric lights, etc. The shop will be 201 feet long by 66 feet in width. The main portion of the building will be 200 feet long, 37 feet wide and 50 feet high in the clear, the two electric cranes running the whole length with 38 feet of clear space above the floor. Large windows will be placed along the sides, giving abundance of light, and a skylight with 12 feet of clear glass will run along the whole roof. Three galleries 28 feet wide will open out on the main shop, extending its entire length. The first two will be occupied by light machinery benches and the top gallery will be arranged for the storage of patterns. Work on the new building will be begun immediately.

The Peckham Motor, Truck and Wheel Company, of Kingston, N. Y., manufacturers of Peckham's patent radial geared trucks, are the recipients of a large number of flattering testimonials from street railway companies, who are using the motor trucks manufactured by this company, among which are noted the following: The Butte City Consolidated Railway Company, of Butte City, Mont., among other things states in regard to these trucks which it is using, "that they have so far given entire satisfaction; that they are very much pleased with them, and that in the future they will use them in place of all others;" the Long Island City and Newtown Railway Company, of Long Island City, N. Y., state "that they have been using radial geared cantilever trucks for about two months, which have given the best of satisfaction, and that they prevent the oscillation of cars, take the curves easily, and are conducive to easy riding;" the Lancaster City and West End Electric Street Railway companies, of Lancaster, Pa., state that they have been using these trucks for about six months, and "that they are giving entire satisfaction, preventing the oscillation of cars, giving a better riding car, and requiring less power than other trucks used, and that, in the opinion of the company, they are all that can be desired for an electric car." A large number of other roads throughout the country are using these trucks, and seem to be entirely satisfied with the service which they are giving.

The Jeffrey Manufacturing Company, of Columbus, O., has recently filled the following orders on mining machinery, power drills, etc.: Robbins' Coal Mining Company, Pittsburgh, one mining machine, one power drill; Sunday Creek Coal Company, Columbus, O., three mining machines, two power drills (second order); Gaslee & Lockwood, Evansville, Ind., one power drill; Hocking Valley Coal Company, Nelsonville, O. (Wm. Job, president, formerly general manager of the Morris Coal Company), five mining machines, three power drills; Union Colliery Company, Victoria, B. C., one electric mine pump; Egyptian Mining Company, Du Quoin, Ill., two power drills; Harris Coal Company, Jobs, O. (additional order), one mining machine; Cambria Mining Company, Cambria, Wyo., five power drills; Monongah Coal-Coke Company, Monongah, W. Va. (additional order), one mining machine; New Pittsburgh Coal Company, Nelsonville, O. (additional order), one power drill; Glen Mary Coal Company, Glen Mary, Tenn., three power drills; Upson Coal Company, Shawnee, O. (additional order), one mining machine; H. D. Turney & Co., Columbus, O., complete electric plant, consisting of engines, boilers, electric machinery, including the Jeffrey mining machines. Coal handling machinery and elevators and conveyors for the following companies: Mt. Carbon Company, Mt. Carbon, W. Va.; No Bend Coal and Coke Company, No Bend, O.; Union Pacific Railway Company, Rock Springs, Wyo.; St. Louis and Big Muddy Coal Company, Carterville, Ill.; Luhrig Coal Washing Company, Mt. Carbon, Ill.; Louder Wooley Coal Company, Evansville, Ind.; Mud River Coal-Coke Company, Mud River, Ky.; Texas & Pacific Coal Company, Thurber, Tex.; New Pittsburgh Coal Company, Farmersburg, Ind.; St. Louis Ore and Steel Company, Murphysboro, Ill.; Crystal Plate Glass Company, St. Louis, Mo.

Business Notices.

Complete Equipment of electric light and power plants with the Mather system. Also agent for the Perkins incandescent lamp. E. T. Pardee, 14 Butler block, Syracuse, N. Y.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The Brown & Sharpe Manufacturing Company, of Providence, R. I., announce that the prices of their swivel vises for use on milling and planing machines have been reduced. Price of No. 2 vise is $24; price of the No. 3 vise is $30. Former prices, $31 and $38.

The Star Electrix Company begins the new year with signs of unusual energy and business push, its latest departure being the offer of a large number of switches, gratis, with orders for its goods. Through a slight mistake of the printer, their advertisement in THE ELECTRICAL WORLD of Jan. 2 was not quite clear in one point, which is corrected in this issue. That is, that with an order for $50 worth of goods they will send seven five-ampère three-point or seven new style 10-ampère switches free of charge. For an order for $100 they will send either 15 three-point five-ampère or 15 10-ampère or five imported China switches.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

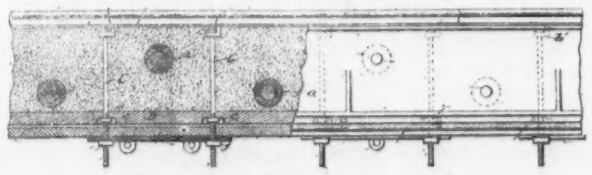
U. S. PATENTS ISSUED DEC. 29, 1891.

465,612. Electric Car Brake; La Motte C. Atwood, of St. Louis, Mo., Assignor to the Atwood Electric Company, of East St. Louis, Ill. Application filed Jan. 10, 1891. In an electric car brake, the combination of the brake shoes, the track-brake, an electric motor, a pivoted stem, a suitable connection between one of the brakes and the stem, a relatively longer connection between the other brake and said stem, and a train-of-gear connection between said motor and said stem, whereby the stem may be removed a greater or less degree, and the respective brakes applied successively.

465,829. Fire or Other Alarm; Hugh M. Browne, of Washington, District of Columbia. Application filed Dec. 24, 1890. A fire or other alarm consisting of a casing containing an india-rubber diaphragm covering hermetically the mouth of a bulb filled with air, a flat bar with a disc and hinge resting upon said diaphragm, a screw held by a bracket over the end of said flat bar opposite to the hinge, and a bulb filled with air arranged on the bottom of said casing, and mechanism for connecting the expansion of the body of air in said bulb with the mechanism of an electric bell.

465,832. System of Synchronism for Telegraphy; Gilbert Alfred Cassagnes, of Paris, France. Application filed June 26, 1891. The combination in a system of synchronous telegraphy in which a single line wire is used, of two vibrating tuning forks governing an electromotor, a current distributor, a trailing finger on said distributor and connected with the line wire, and an electrical pitch-varying means at the receiving station, whereby the vibrations of the said forks may be made equal or unequal at will.

465,844. Electric Railway; Julius Emmner, Jr., of Washington, District of Columbia, Assignor by direct and mesne assignments to Philip T. Dodge, trustee of same place. Application filed Oct. 30, 1890. In an electric railway, a tunnel or conduit having a longitudinal opening, an external car, a contact arm connected to the car and extending into the tunnel to contact with the conductor and a wheeled support for said contact device,



No. 465,886.—ELECTRIC RAILWAY.

said support constructed to admit of a tipping movement of the arm on a horizontal axis.

465,853. Electric Machine; Thomas Hammill Hicks, of Detroit, Mich., Assignor of two-thirds to George F. Case and E. D. Richmond, of same place. Application filed May 9, 1890. In an electric machine, field-cores, each wound with two conductors, one conductor traversed by a current impulse in one direction, and the other conductor traversed by a current impulse of opposite direction and terminating in separate brushes, having in combination there-with a current selector and distributor having sliding contact with said brushes, one of said brushes collecting the impulse of one direction and sending them through one of the field-condustors and the other brush collecting the impulses of the opposite direction and sending them through the other field-conductor.

465,854. System of Electric Distribution; Thomas H. Hicks, of Detroit, Mich, Assignor of one-half to George F. Case, of same place. Application filed Dec. 26, 1890. In a system of electrical distribution and conversion, the combination, with two induction circuits, of two commutators rotatable together, each commutator divided into two sects of bars electrically insulated from each other and separate collectors with which each set of commutator bars is in electrical contact, one collector being in electrical contact with one induction circuit and the other collector being in electrical contact with the other induction circuit.

465,855. Alternating-Current Dynamo; Thomas H. Hicks, of Detroit, Mich. Assignor of one-half to H. L. Obetz, of same place. Application filed Jan. 3, 1891. In an alternating current dynamo, the combination with field poles of opposite magnetic signs alternately arranged at equal distances from each other and each made of a width equal to the distance each is spaced from the adjacent pole of an armature wound with coils arranged in pairs, each coil having convolutions forming a central opening, the width of the opening and of the parallel conductors on each side of the opening each of a width equaling the width of one of the field poles, the two coils of each pair crossing each other at the ends of the armature and filling the said spaces of one another, each pair of coils when arranged upon the armature

occupying an arc of its circumference equal to the width of two field poles and two field spaces and extending the length of said armature, and two or more of said pairs arranged in linear series with each other.

465,866. Sliding Clamp for Electric Welding Apparatus; Hermann Lemp, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Jan. 19, 1891. The combination of a conducting-slide, a stationary conducting part connected to a source of electric energy, and an interposed yielding or adjustable block or blocks having adjustable contact-faces, one making connection with the slide or a part moving therewith and adapted to preserve connection as the slide moves over the stationary conducting part and the other making connection with the fixed part and adapted to preserve connection therewith on movement of the slide in a direction away from such fixed part.

465,886. Electric Railway; Henry S. Pruyn, of Hoosick Falls, Mass. Application filed June 25, 1890. In an elevated track for electric railways, the combination, with two girders supporting a rail and having outwardly and downwardly inclined flanges, of electric conductors secured below said flanges and inside their outer edges. (See illustration.)

465,888. Covered Electric Conductor; Thomas L. Reed, of Providence, R. I. Application filed Nov. 18, 1890. A wire for electrical purposes having a covering composed of braided strands and straight wire strands not braided inclosed between the two sets of braided strands.

465,909. Door Bell; Frank M. Winters, of Chicago, Ill., Assignor of one-half to Albert H. Baldwin, of same place. Application filed June 1, 1891. In a door bell apparatus a bell operated by clockwork which is set in motion by a magnetic electric machine situated at the door and operated by hand.

465,949. Electric Cane; Alfred W. Roovers and Alexander H. Roovers, of Brooklyn, N. Y. Application filed March 13, 1891. A cane having a tubular upper part, a conductor arranged within this tubular upper part, an induction coil arranged in said tubular upper part, a spring for holding the battery in contact with the core of the induction coil, and electrical connections.

465,958. Lightning Arrester; Alexander Wurts, of Pittsburgh, Pa., Assignor to the Westinghouse Electric and Manufacturing Company, of same place. Application filed Oct. 5, 1891. The combination, with an alternating-current electric generator, of two discharge-plates, one constantly moving with reference to the other, said plates being so located with reference to each other that they will pass at the moment of a neutral point in the wave phase of the electromotive force. (See illustration.)

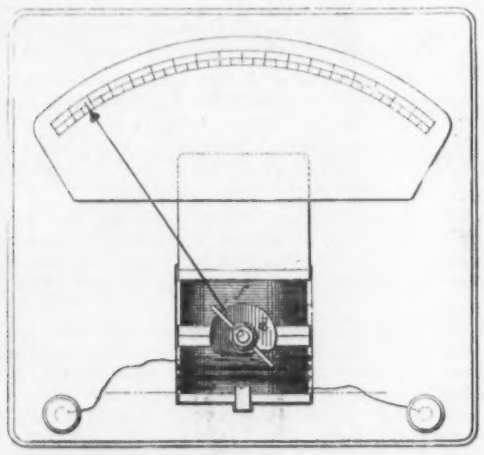
465,961. Insulator. Giuseppe Sacco Albanese, of Orange, N. J. Application filed April 3, 1891. An insulator having an annular groove or neck, a fastening device composed of a neck-band, a locking lever pivoted to said neck-band, and a bail connected pivotally to the locking-lever, and provided with a bent-up or hook-shaped portion for engaging the line wire, and applying it to the neck of the insulator when the lever is moved into locked position on the same.

465,970. Armature Connection for Motor or Generators; Thomas A. Edison, of Llewellyn Park, N. J. Application filed March 26, 1891. The combination of an armature coil, a commutator having commutator-segments in sections separated from each other, but connected through resistance conductors, and conductors connecting the armature coil with the first section of each segment, whereby as the commutator moves relatively to the commutator brushes the resistances between the sections are thrown into circuit in series one after another.

465,971. Means for Transmitting Signals Electrically; Thomas A. Edison, of Menlo Park, N. J. Application filed May 23, 1885. Means for signaling between stations separated from each other, consisting of an elevated condensing surface or body at each station, a transmitter operatively connected to one of said condensing surfaces for varying its electrical tension in conformity to the signal to be transmitted, and thereby correspondingly varying the tension of the other condensing surface, and a signal receiver operatively connected to said other condensing surface.

465,973. Armature for Dynamos or Motors; Thomas A. Edison, of Llewellyn Park, N. J. Application filed March 23, 1891. An armature for dynamos or motors, having a winding of two wires of different specific resistances, in combination with the commutator, conductors connecting the commutator with the wire of higher resistance, and connections between the wires at intervals. (See illustration.)

465,981. Electrical Pyrotechnics; Pierre Charles Eugene Champion, of Paris, France. Application filed May 15, 1891. The combination of a series of electric lamps with a keyboard and a commutator and with a conductor from a series of lamps to the keyboard, and with conductors from each of the lamps of one series to the commutator, corresponding lamps of the different series connecting with like contacts of the commutator.



NO. 466,087.—TEMPERATURE REGULATING DEVICE FOR ELECTRICAL CIRCUITS.

465,983. Cut-Out; Henry W. Fisher, of Pittsburgh, Pa. Application filed March 2, 1891. A cut-out mechanism, consisting of an automatically movable bar adapted when in normal position to form electrical connection between two terminals, needles adjustably connected to the conductors of the main circuit, and a filament for controlling the movement of the movable bar and passing between the adjacent points of the needles.

465,989. Signal-Transmitting Apparatus and System; Henry A. Chase, of Boston, Mass., Assignor to Albert Watte, of same place. Application filed May 4, 1891. A system for transmitting signals comprising a metallic circuit provided with one or more transmitting mechanisms, a main-line battery in multiple with the metallic circuit, a ground tap normally disconnected from the main line, and provided with a single relay and battery, and a switch to connect both sides of the line with the ground tap, whereby a single relay may receive the signal transmitted over either side of the line.

465,990. Signal-Transmitting Mechanism; Henry A. Chase, of Boston, Mass., Assignor to Albert Watte, of same place. Application filed July 10, 1891. A system for transmitting signals, comprising a metallic circuit, a signal transmitting mechanism to operate it, means for positively changing the rate of movement of the motor mechanism and thereby of the speed of the transmitting mechanism, and two relays included in the metallic circuit in multiple with each other.

465,991. Electric Signaling Apparatus; Frederick W. Cole, of Newton, Mass. Application filed Jan. 6, 1890. A signal box comprising a break wheel and actuating motor therefor, having different ranges of movement capable of producing different numbers of rotations of said break wheel at each operation of the box, a shunt for said break wheel and switch therein, and actuating devices for said switch operated by the break wheel motor, which cause the closing of said switch immediately after the motor begins to operate, and open the said switch during the last rotation of the break wheel.

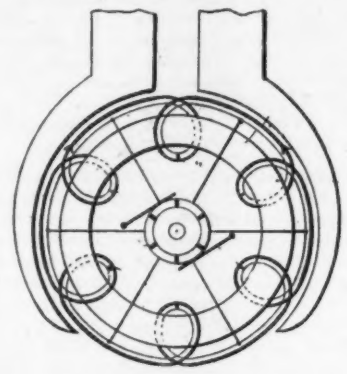
465,994. Alternating-Current Dynamo; Thomas H. Hicks of Detroit, Mich., Assignor of one-half to H. L. Obetz, of same place. Application filed March 9, 1891. In an alternating-current machine the combination, with field-poles of opposite magnetic sign alternately arranged with each other, of an armature rotatable between said field-poles wound with an inductor, forming coils, connected in series, each coil having a centre space one third the width of the coil, and each pair of coils separated from each other by a space equaling said centre space, said field poles each of a width of said centre space of the armature coils and spaced from each other a distance equal to the width of each pole.

465,997. Electrical Switch; George B. Martratt, of Troy, Assignor of one-half to Charles E. Martratt, of Albany, N. Y. Application filed Dec. 6, 1890. In an electrical switch and safety box, the combination of a box containing switching mechanism, made in two end covered semi-cylindrical parts, with one of the latter adapted to slide around past the other in a groove made in the box bottom.

465,999. Brake for Electric Motors; Alton J. Shaw, of Muskegon, Mich. Application filed Sept. 21, 1891. With an electric motor having a field magnet or magnets and an armature, one adapted and arranged to rotate and the other free to move or oscillate a limited distance, and a brake connected with and controlled by the part having a limited play or movement.

466,011. Electric Pendulum Clock; Henry Phillips, of New York, N. Y. Application filed March 11, 1891. In an electric pendulum clock, the combination, with the pendulum of the sliding and vertically swinging switch actuated thereby and having an electric contact piece, and the vibrating brush also actuated by the pendulum, said switch having a pivot-support near one end and intermediate support on the vibrating brush, and thereby having electrical contact with the brush in the movements of the pendulum in one direction only and avoiding said contact in the movements in the reverse direction.

466,028. Governing Device for Electric Motors; William Baxter, Jr., of Baltimore, Md. Application filed April 14, 1891. In a governing device for electric motors, the combination, with the rod reciprocated by the governor, of a pivoted roller carried



NO. 465,973.—ARMATURE FOR DYNAMOS OR MOTORS.

thereby and a series of inclined spring contacts having the line of their bases parallel with the movement of the rod and their points projected in the path of the roller and the roller traversed over such springs longitudinally.

466,037. Electrically Operated Elevator; Frank E. Herdman, of Indianapolis, Ind. Application filed Feb. 24, 1891. An elevator having a worm, a lever, connection between said lever adapted to move with said worm, a tension device connected to said lever and intermediate connection between said lever and the source of power, whereby when the movement of the worm exceeds the tension device the lever moves and shuts off the power.

466,052. Electric Plug Circuit-Closer; James S. Kimball, of Boston, Mass. Application filed Jan. 22,, 1891. The invention consists in a plug or attachment for electric translating devices, one member being provided with a circuit terminal, the second member being inserted through the first member and provided with a circuit terminal, one of the said members being movable, and conducting cords connected to the stationary member.

466,053. Electric Signaling Apparatus; Bernice J. Noyes, of Boston, Mass. Application filed Nov. 4, 1890. Several signal boxes, each containg an answer back bell, an answer-back circuit changing device for said answer-back bells, an electromagnet which controls the operation of said answer-back circuit-changing device, an independent circuit for said electromagnet, a receiving instrument controlled by said independent circuit, a multiple signal-transmitting apparatus controlling the operation of said independent circuit, and a switch controlled by a movable member of said multiple signal-transmitting apparatus for introducing the actuating electromagnet for the answer-back circuit-changing device.

466,063. Electric Annunciator; Frank C. Colville, of Oakland, Cal. Application filed March 26, 1891. In combination with the drop curtain in an electric annunciator, an upwardly bent catch wire or rod adapted to engage the curtain at the upper part and forming also a pivot for the armature, or fixed to that part at the centre of movement.

466,086. Mechanical Telephone; Henry B. Thompson, of Pittsburgh, Pa. Application filed June 13, 1891. In an acoustic telephone, the combination of a primary disc having radical extensions at its periphery and a supporting-frame having radical spokes or arms to which such extensions of the primary disc are connected.

466,087. Temperature Regulating Device for Electrical Circuits; Edward Weston, of Newark, N. J. Application filed June 4, 1891. An electrical circuit composed of a conductor the electrical resistance of which increases with augmented temperature and a conductor the resistance of which decreases with augmented temperature, the said conductors being disposed in such proximity that heat received from the said first conductor may augment the temperature of said second conductor. (See illustration.)

466,101. Electric Railway Switch; Max Kerstein, of Boston, Mass., Assignor of two-thirds to Henry Cramer and Robert Fabery, of same place. Application filed May 16, 1891. In an electric railway switch, the combination, with the movable switch member, of an armature carrying arm or stud projecting downwardly from the same, an armature thereon, electromagnets on opposite sides of said armature adapted when energized to attract the said armature and thus move the said movable switch member, the trolley wire, trolley arm, contact levers supported by the trolley wire and adapted to be electrically connected, the said contact levers being electrically connected with the said electromagnets, and movable arms on the trolley arms to move the contact levers to close the circuit and energize one or the other of the electromagnets.

466,131. Art of and Apparatus for Heating Metal Articles by Electricity; Edwin E. Angell, of Somerville, Mass., Assignor to the Electrical Forging Company, of Maine. Application filed March 16, 1891. In an electric heater, the combination of two electrodes disposed in position for contact with opposite ends of the articles or electrodes disposed in position for contact with the sides of said article.

466,132. Electric Forge; Edwin E. Angell, of Somerville, Mass., Assignor to the Electrical Forging Company, of Maine. Application filed March 18, 1891. In an electric forge, the combination of two electrode levers pivoted at opposite points and inclined rearwardly toward each other, the inner ends of said levers being adapted to receive between them a bar to be heated.

466,133. Electric Forge; Edwin E. Angell, of Somerville Mass., Assignor to the Electrical Forging Company, of Maine. Application filed March 23, 1891. In an electric forge, the combination of a work holder having clamping electrodes connected with one pole and provided with notches of different shapes for different tools, and an adjustable electrode connected with the other pole.

466,138. Secondary Battery Plate; Henry G. Morris and Pedro G. Salom, of Philadelphia, Pa. Application filed July 5, 1890. A compound of sulphide of lead and a binder from which is formed the spongy lead active material of a secondary battery plates.

466,159. Annunciator; William C. Dillman, of Brooklyn, Assignor to Owen Walsh, of New York, N. Y. Application filed July 10, 1891. The combination, with a speaking tube and an electric bell, of a drop leaf arranged at the mouth of the tube and forming one terminal of the bell circuit, a yielding contact arranged adjacent to the drop leaf and forming the other terminal of the bell circuit, and a projection on the leaf adapted to strike and pass the yielding contact when the leaf is dropped.

466,177. Galvanic Battery; Samuel Miller, of Buxton, England, Assignor to Evelyn Glover, of same place. Application filed Oct. 30, 1889. A primary battery comprising in combination the following elements: a case or vessel, a carbon element in the form of a cylinder or box embedded in pitch or similar substance and containing the depolarizing liquid, a porous box inclosed by the carbon box and containing an acid solution, and a zinc element in said porous pot.

466,180. Electrically-Driven Locomotive; Everard Home Morgan, of Dover, England. Application filed March 9, 1891. The combination with the ordinary frame and drive-wheels of a locomotive, of a storage-battery and dynamo, arranged in the space usually occupied by the boiler and engine, a pinion on the axis of the dynamo, a transverse shaft, provided with a pair of cranks and a gear wheel engaging the pinion on the axis of the dynamo, the cranks on the axis of the driving wheels, and the connecting-rods between the cranks on the traverse gear-wheel shaft and the cranks on the axle of the driving wheels.

466,196. Electric-Railway Trolley and Support; Wilbur A. Stevens, of Kansas City, Mo. Application filed September 22, 1890. The combination of an oblique support, a line wire rigidly attached thereto, a grooved pulley adapted to travel on said wire, a suitable frame provided with a single rigid depending arm, and in which frame the pulley is journaled, a weight attached to said depending arm for balancing the pulley on the line wire, and means for connecting said frame with a car, said connection being made with the depending arm at a point intermediate between the weight and pulley.

466.244. Electric Switch; William J. Kelly, of Boston, Mass., Assignor to John P. Cushing, of same place. Application filed June 29, 1891. In a circuit controlling device or switch, the combination, with two sets of circuit terminals, one of said circuit terminals being composed of a movable member and a stationary member, of reciprocating contact carriers co-operating with the said circuit terminals, and a mechanism to produce reciprocations of the contact carriers, the said movable member being capable of being disconnected from its co-operating fixed member, to operate.

466,245. Controlling Apparatus for Incandescent Lights; William J. Kelly, of Boston, Mass., Assignor to John P. Cushing, of same place. Application filed Aug. 7, 1891. The combination, with a main supply circuit and an adjustable current regulator included therein, of a plurality of loops connected to said regulator and provided with one or more translating devices, a switch in each loop to connect and disconnect the said loops from the current regulator, and an auxiliary loop for each of said loops connected directly to the main supply circuit, and a switch in each of said auxiliary loops.

466,250. Electric Conductor; Joseph W. Marsh, of Pittsburgh, Pa., Assignor to the Standard Underground Cable Company, of same place. Application filed Sept. 30, 1891. The invention consists of an open frame formed of non-conducting material, wires arranged on opposite sides of the frame, and a perforated strip of fibrous material surrounding the frame and wires, and binding the latter in position on the frame.

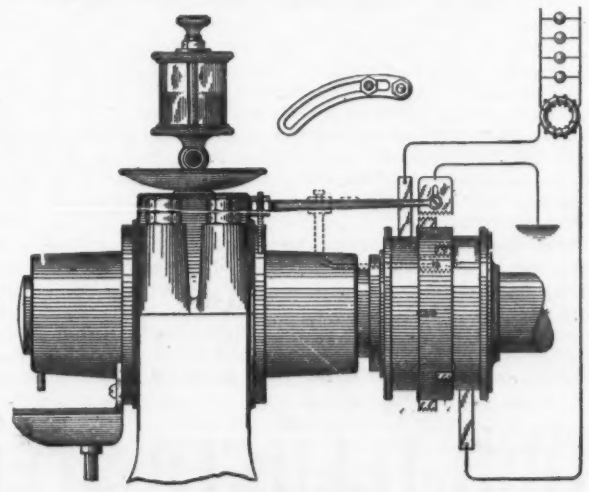
466,258. Electric Cable; William A. Conner, and Joseph W. Marsh, of Pittsburgh, Pa., Assignors to the Standard Underground Cable Company, of same place. Application filed Feb. 10, 1890. An electric cable of conductors adapted to be used in pairs for metallic circuits, the two wires of a pair or circuit being separated from each other a greater distance than the adjacent wires of adjoining circuits.

466,266. Electric Heating Tool; George W. Blanchard, of Waterville, Me., Assignor to the Electrical Forging Company of Maine. Application filed April 3, 1891. An electric heating device consisting of tongs, with two electrodes, one secured to each jaw of the tongs and electric conductors secured to said electrodes.

466,288. Lamp Socket; Jesse L. Hinds, of Syracuse, N. Y., Assignor to the Electric Engineering and Supply Company, of same place. Application filed July 23, 1891. The invention consists in an non conductor base plate, a terminal carrying bracket secured to the base and adapted to support the lamp, a U-shaped bracket also secured to the base plate and provided with a second terminal, a circuit opening and closing spring interposed between the base plate and bracket, a cam for rocking said spring arm, a spindle having one extremity connected to said camwith a loose motion between the two and the other formed with alaterally-extending shoulder, and a hand piece formed with a depressed shoulder adapted to engage the laterally-extending shoulder of the spindle.

466,289. Lamp Socket; Jesse L. Hinds, of Syracuse, N. Y., Assignor to the Electric Engineering and Supply Company, of same place. Application filed July 23, 1891. In combination, an insulator base-plate, a bracket consisting of a ring and oppositely arranged arms secured to the base plate, a second insulator plate supported on the ring of the bracket, a lamp engaging socket secured to the second insulator plate and moving lamp engaging arms on said socket.

466,290. Lamp Socket; Jesse L. Hinds, of Syracuse, N. Y. Assignor to the Electric Engineering and Supply Company, of same place. Application filed July 23, 1891. The combination, with



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an insulator base, of a bracket having depending end arms, and a central arm or lug, a terminal carried by the central arm, a spindle journaled in the depending end arms, a cam on the spindle, a spring having one extremity disposed on the outside of the bracket arm, and formed with a foot engaged with said bracket, a laterally extending arm on said spring having a projecting bearing face adapted to be forced by said cam into engagement with one of the lamp terminals, a bracket having one extremity secured to the insulator base, and the other provided with a nipple adapted to engage the other lamp terminal, and a terminal on the bracket.

466,306. Electric Fire-Alarm System; Henry E. Jacobs, of Milwaukee, Wis., Assignor to Frank G. Bigelow, Moses H. Brand, and George Knowles, Jr. Application filed March 23, 1889. The combination with an electric motor and contact-collar revolved thereby, the latter having a continuous and an intermittent contact surface, of a brush bearing on the continuous contact-surface and wired to the motor-magnet, an electric circuit including a thermostat, a magnet and its armature, contact posts between which one end of the armature depends, two brushes resting on the intermittent contact-surface of the motor-collar and wired each to one of the contact posts last named, a wheel revolved by the motor, having horizontal pins projecting from it in series, and a brush normally in circuit with a signal box, but projecting in the path of the pins aforesaid.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.